

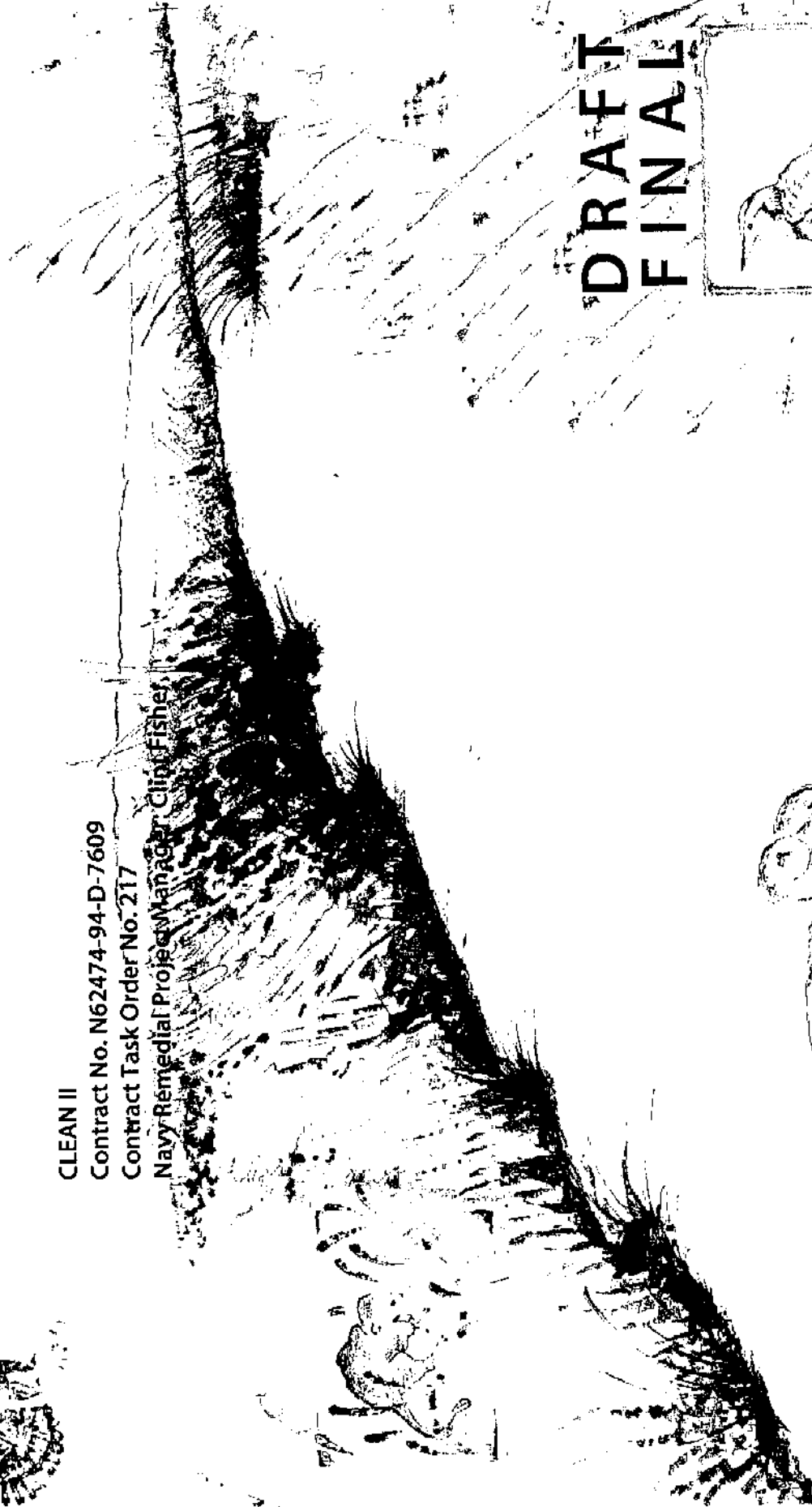
**Remedial Investigation  
Tidal Area Sites 1, 2, 9, and 11  
Naval Weapons Station, Seal Beach Detachment  
Concord, California**

**CLEAN II**

**Contract No. N62474-94-D-7609**

**Contract Task Order No. 217**

**Navy Remedial Project Manager: Clint Fisher**



**DRAFT  
FINAL**



**Remedial Investigation**

**June 1999**

**Volume 1 of 4**



**COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)  
Northern And Central California, Nevada, And Utah  
Contract No. N62474-94-D-7609  
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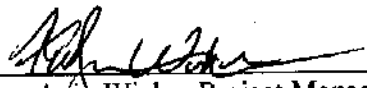
**Prepared for**

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**DRAFT FINAL  
REMEDIAL INVESTIGATION REPORT  
TIDAL AREA SITES  
NAVAL WEAPONS STATION, SEAL BEACH DETACHMENT CONCORD  
August 6, 1999**

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## ABBREVIATIONS AND ACRONYMS

ARAR	Applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
atm-m <sup>3</sup> /mol	Atmosphere-cubic meter per mole
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient water quality criteria
BCDC	Bay Conservation and Development Commission
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
Cal/EPA	California Environmental Protection Agency
CCCMADVC	Contra Costa County Mosquito Abatement District-Vector Control
CDFG	California Department of Fish and Game
CEC	Cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract laboratory program
cm/s	Centimeter per second
COPC	Chemical of potential concern
CRP	Community Relations Plan
CS	Confirmation sampling
CTO	Contract Task Order
CZMA	Coastal Zone Management Act
DDT	Dichlorodiphenyltrichloroethane
DERP	Defense Environmental Restoration Program
DL	Detection limit
DNAPL	Dense nonaqueous-phase liquid
DQO	Data quality objective
DTSC	California Department of Toxic Substances Control
E&E	Ecology and Environment
EFA WEST	Engineering Field Activity West
EPA	U.S. Environmental Protection Agency
ER-L	Effects range-low
ER-M	Effects range-median
ESQD	Explosive Separation-Quantity Distance
FFA	Federal Facility Agreement
FFSRA	Federal Facility Site Remediation Agreement
FGC	California Fish and Game Code

## ABBREVIATIONS AND ACRONYMS (Continued)

FS	Feasibility study
FSP	Field sampling plan
HHRA	Human health risk assessment
HI	Hazard index
HMX	Cyclotetramethylene tetranitramine
HPCDD	Heptachlorodibenzodioxin
HPCDF	Heptachlorodibenzofuran
HQ	Hazard quotient
HRS	Hazard Ranking System
HSP	Health and safety plan
IAS	Initial assessment study
ICP	Inductively coupled plasma
ICS	Interference check sample
IR	Installation restoration
IRP	Installation Restoration Program
IT	International Technology Corporation
$K_{oc}$	Organic carbon partition coefficient
$K_{ow}$	Octanol water partition coefficient
LNAPL	Light nonaqueous-phase liquid
mEq/100g	Milliequivalent per 100 grams
mg/kg	Milligram per kilogram
mg/kg/day	Milligram per kilogram per day
mg/L	Milligrams per liter
mph	Miles per hour
MS/MSD	Matrix spike/matrix spike duplicate
msl	Mean sea level
NAPL	Nonaqueous-phase liquid
NAS	National Academy of Science
Navy	U.S. Department of the Navy
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NFEC	Naval Facilities Engineering Command
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NWS SBD	Naval Weapons Station, Seal Beach Detachment

## ABBREVIATIONS AND ACRONYMS (Continued)

OC	Organochlorine
OCDD	Octachlorodibenzodioxin
PAH	Polynuclear aromatic hydrocarbon
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PCP	Pentachlorophenol
PID	Photoionization detector
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
QCSR	Quality control summary report
QEA	Qualitative ecological risk assessment
RCRA	Resource Conservation and Recovery Act
RCRA	Resource Conservation and Recovery Act
RDA	Recommended Daily Allowance
RFA	RCRA facility assessment
RfD	Reference dose
RI	Remedial investigation
RME	Reasonable maximum exposure
RMP	Regional Monitoring Program
ROD	Record of decision
RWQCB	California Regional Water Quality Control Board
SAP	Sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act
SDG	Sample delivery group
SF	Slope factor
SFEI	San Francisco Estuary Institute
SI	Site investigation
SOP	Standard operating procedure
SQL	Sample quantitation limit
SVOC	Semivolatile organic compound
SWI	Sediment-water interface
SWMU	Solid waste management unit
TBC	To be considered



## ABBREVIATIONS AND ACRONYMS (Continued)

TCA	Trichloroethane
TCDD	Tetrachlorodibenzodioxin
TCE	Trichloroethene
TCL	Target compound list
TDS	Total dissolved solids
TEQ	Toxic equivalent
TIC	Tentatively identified compound
TOC	Total organic carbon
TPH-e	Extractable total petroleum hydrocarbons
TPH-p	Purgeable total petroleum hydrocarbons
TRV	Toxicity reference value
TSS	Total suspended solids
TiEMI	Tetra Tech EM Inc.
UCL	Upper confidence limit
USC	United States Code
USCS	Unified Soil Classification System
USFWS	U.S. Fish and Wildlife Service
USFWS	U.S. Fish and Wildlife Service
UST	Underground storage tank
VOC	Volatile organic compound
WP	Work plan
$\mu\text{g/dL}$	Micrograms per deciliter
$\mu\text{g/kg}$	Micrograms per kilogram
$\mu\text{g/L}$	Micrograms per liter



## EXECUTIVE SUMMARY

This report presents the results of, and recommendations based on, a remedial investigation (RI) conducted at four Tidal Area sites at Naval Weapons Station, Seal Beach Detachment (NWS SBD) Concord, California (Figure 1-1). The Tidal Area sites (Figure 1-2) include:

- Site 1 - Tidal Area Landfill Site
- Site 2 - R Area Disposal Site
- Site 9 - Froid and Taylor Roads Site
- Site 11 - Wood Hogger Site

The main purposes of the RI were to (1) characterize the geology and hydrogeology of the Tidal Area sites; (2) assess the nature and extent of soil, sediment, and surface water contamination at each site; (3) conduct screening-level human health risk assessment (HHRA) and qualitative ecological risk assessment (QEA); and (4) assess the potential migration of chemical constituents found to present a potential risk to human health or the environment.

Soil, sediment, and surface water were sampled in July 1995 and August 1995, and surface water was sampled again in October 1995, January 1996, and April/May 1996 to evaluate environmental conditions and to assess the need for cleanup actions at the sites. Additional data was collected in 1998 to fill specific data gaps that were identified after the draft QEA report was submitted in 1997. In October 1997, 23 wells in the tidal area were sampled and groundwater was analyzed. The results of the RI are summarized below by site, along with recommendations for each site. The investigation of Otter Sluice is also summarized in the following sections.

### TIDAL AREA SITES

The following paragraphs provide a brief explanation of each site and the reason the area was identified for environmental investigation.

**Site 1 - Tidal Area Landfill Site.** The waste disposal area of the Tidal Area Landfill served as the major disposal area for NWS SBD Concord from approximately 1944 to 1979. The landfill reportedly received solvents, acids, paint cans, creosote-treated timbers, asphalt, concrete, asbestos, and ordnance materials, including inert munitions.

For the purposes of investigating and evaluating risk to human health and ecological receptors, Site 1, the Tidal Area Landfill, is divided into two areas. The first area is the Tidal Area Landfill itself, which lies within the boundary of former waste disposal. The second area lies beyond the area of former waste disposal and is actually a subpart of the R Area Disposal. Only the second area, which lies within the R Area Disposal site, is evaluated in detail in this RI report.

The first area of the Tidal Area Landfill, where waste was dumped, is currently in the record of decision (ROD) phase under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Tidal Area Landfill ROD is expected to be signed before the end of 1999. The ROD documents the selection of a landfill cap as the most appropriate remedial action for the disposal area of the Tidal Area Landfill. The landfill disposal area was not evaluated as a part of this RI because characterizing landfill contents and evaluating risk to receptors is unnecessary within the boundaries of landfills according to U.S. Environmental Protection Agency (EPA) guidance documents (EPA 1991, 1993a). This area is expected to be capped once the ROD is signed and the detailed design is completed.

For the purposes of this RI report, the Tidal Area Landfill refers to land within the R Area Disposal Site but just outside the Tidal Area Landfill waste disposal area. This perimeter land was investigated in detail to see if toxic chemicals—which are potentially present within the Tidal Area Landfill—have migrated into the R Area Disposal Site. Because the Tidal Area Landfill is actually part of the R Area Disposal site, the remedy selection for this area will be documented as the remedy for the R Area Disposal Site. Although the Tidal Area Landfill perimeter area and the R Area Disposal Site are considered separately throughout this report, combining these areas into one site is logical in the ROD phase for three reasons. These include the following: (1) both areas are visually indistinguishable from each other, (2) neither area contains toxic chemicals identified at concentrations that are considered a threat to human health or ecological receptors, and (3) the recommended remedy for both areas (no further action) is identical.

**Site 2 - R Area Disposal Site.** From the late 1940s until about 1976, the area adjacent to the eastern side of Baker Road, between the Segregation Areas (R Buildings) along Froid Road, and the Inert Storage Area (S Buildings) along Pickett Road, was used for the disposal of materials generated while segregating conventional munitions returned from Pacific operations. This disposal area became the R Area Disposal Site. In planning the RI, the eastern site boundary was moved to the boundary of the Tidal Area Landfill Site to allow for a more complete investigation of the area between these two sites.

**Site 9 - Froid and Taylor Roads Site.** The Froid and Taylor Roads Site is located at the intersection of Froid Road and Taylor Boulevard. A piece of spent ordnance was found near the intersection of these roads, and some scrap metal and other debris were found south of the intersection during a previous investigation. The site was defined as the area from the eastern boundaries of the Tidal Area Landfill and Wood Hogger Sites to the intersection of Froid Road and Taylor Boulevard.

**Site 11 - Wood Hogger Site.** The Wood Hogger Site was used between 1969 and 1973 for chipping dunnage and wood scrap from Tidal Area operations. An incinerator was formerly used to burn wood scrap. Some of the wood chips were deposited on the ground adjacent to the wood hogger machinery. Some of the wood likely come from ordnance crates returned from Vietnam, which were probably treated with pentachlorophenol. The site consists of an area surrounding the wood hogger machinery and potential wood chip disposal areas. The site surrounds solid waste management unit (SWMU) 37 site, so data from the Resource Conservation and Recovery Act facility assessment confirmation study investigation at SWMU 37 are included in the RI at the Wood Hogger Site.

**Otter Sluice.** Otter Sluice was never established as a separate installation restoration (IR) site because there is no record of direct contamination spills or releases to Otter Sluice. Otter Sluice was evaluated in this RI as a separate area, based on state and federal regulatory agency comments received after the draft RI was prepared. Additional evaluation of Otter Sluice was performed to evaluate (1) the potential release of contamination into Otter Sluice (2) the potential for exposure of receptors to toxic constituents that may have settled in Otter Sluice from other Tidal Area IR sites. Otter Sluice was evaluated as a potential hazard to animal receptors but was not evaluated from a human health risk standpoint due to the lack of contaminants and the lack of a complete exposure pathway of potential contaminants to humans. Because Otter Sluice was not evaluated as a part of the HHRA, Otter Sluice is evaluated in detail in Volume II instead of Volume I of this report. A summary of the ecological conclusions and recommendations for Otter Sluice is presented in Section 9.0 of Volume I of this RI report.

## **HUMAN HEALTH RISK ASSESSMENT**

The objective of the HHRA conducted at the Tidal Area sites was to evaluate the potential carcinogenic risks and noncarcinogenic hazards associated with chemicals of potential concern and to identify the

chemicals (risk drivers) for which the carcinogenic risk<sup>1</sup> exceeds  $10^{-6}$  or the hazard index<sup>2</sup> exceeds 1. The HHRA was conducted using a screening-level approach in which data from the four Tidal Area sites were compared to regulatory benchmarks (EPA preliminary remediation goals [PRG]). PRGs based on target cancer risks of  $1 \times 10^{-6}$  and target hazard quotients of 1.0 were used. Both residential and industrial receptors were evaluated in the HHRA. NWS SBD Concord is not slated for closure and residential development at the Tidal Area sites is highly unlikely even if the property is transferred to other owners. However, the residential exposure scenario is conventionally used to evaluate an unrestricted land-use exposure scenario because the residential land-use scenario represents the greatest potential for exposure to site contaminants.

The reasonable maximum exposure (RME) risks for potential future residents and industrial workers at the Tidal Area sites are within the EPA's target risk range of  $10^{-6}$  to  $10^{-4}$ , with the exception of the Wood Hogger Site, which exceeds the target risk range for the residential scenario. Dioxins and furans and PAHs are the primary contributors to the cancer risk estimates for the Wood Hogger Site. The RME hazard indices for all sites are below the threshold value of 1, with the exception of the residential scenario at the Tidal Area Landfill (RME hazard index of 1.6 resulting from arsenic in the soil).

Estimated ambient concentrations of metals (primarily arsenic) are the major contributors to risks and hazards at the Tidal Area sites. (Estimated ambient concentrations of metals are the concentrations believed to be naturally present in the soil and not resulting from site activities.) Secondary contributors to risks and hazards at the sites are polynuclear aromatic hydrocarbons (PAH) present at concentrations comparable to ambient levels in urban and rural soils.

Although the residential exposure scenario was evaluated, it does not represent the current or anticipated future land use for any of the tidal area sites. Consequently, risk to human health was evaluated primarily through the industrial land-use scenario. It should be noted that the industrial land-use scenario is useful for evaluating worker exposure, but it assumes 250 days per year and 25 years of exposure. Current and anticipated future land use at the tidal area sites is significantly less than the industrial land-use scenario estimate; therefore, the industrial scenario risk calculations are anticipated to significantly overestimate the actual risk.

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<sup>1</sup> A carcinogenic risk of  $10^{-6}$  is defined as a 1 in a million risk of a person developing cancer from site chemicals when exposed to the defined, on-site exposure conditions assumed in the risk assessment.

## ECOLOGICAL RISK ASSESSMENT

The objective of the QEA (contained in Volume II of this RI) at the Tidal Area sites at NWS SBD Concord was to identify risk to ecological receptors resulting from site activities at the Tidal Area sites. The methods to establish risk to receptors at the Tidal Area sites were developed by the U.S. Department of the Navy (Navy) in consultation with the regulatory agencies, and are in accordance with the EPA's "Superfund Ecological Risk Assessment Guidance" (EPA 1997).

To evaluate risk to receptors, the QEA drew from two data sources: (1) data collected during the 1995 RI and (2) additional data collected in 1998 to fill in specific data gaps that were identified after the draft QEA report was submitted in 1997. The following lines of evidence were used to assess each site receptor's exposure to the potential toxic effects of chemicals:

- Flora and fauna surveys to identify key receptors and document the presence of special status species
- Chemical analyses of soil, sediment, surface water, and waste extraction test samples to evaluate the nature and extent of contamination; comparison of site chemistry to toxicity-based benchmarks that indicate effects
- Measurements of other parameters such as grain size, pH, and total organic carbon that aid in estimating the bioavailability of chemical stressors
- Bioassays to evaluate direct toxicity to invertebrates and fish
- Chemical analyses of tissue residue of selected plants, invertebrates, and vertebrates to evaluate the potential for bioaccumulation and trophic transfer of chemicals
- Food-chain modeling to determine potential doses received by representative birds and mammals

Risks to each type of receptor were then characterized using a weight-of-evidence approach. As part of the this approach, several lines of evidence were evaluated to determine whether a site poses a significant risk to ecological receptors to warrant additional evaluation or a response action. The results of the QEA and recommendations for each site are presented below.

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<sup>2</sup> The hazard index of less than 1 indicates no potential for noncarcinogenic health effects.

## CONCLUSIONS AND RECOMMENDATIONS

The objectives of the RI, which were developed in a series of meetings held with the regulatory agencies, were to identify risk to human health and ecological receptors resulting from site activities at the Tidal Area sites. Sufficient environmental data exist to support a decision for the Tidal Area sites.

The land at the perimeter of the Tidal Area Landfill (known as Site 1 in this report) is located within the R Area Disposal Site. NFA is recommended to address this portion of the R Area Disposal Site. All other land within the R Area Disposal Site is also recommended for NFA. No separate IR site has been established for Otter Sluice because it is adjacent to the R Area Disposal Site and the Wood Hogger Site, and because no contamination source has been associated with Otter Sluice. Decisions under CERCLA regarding Otter Sluice will therefore be associated with the R Area Disposal Site and the Wood Hogger Site. For the purpose of evaluating the entire length of Otter Sluice as single habitat unit, this RI evaluates Otter Sluice separately from the R Area Disposal Site and Wood Hogger Site. Because the entire R Area Disposal Site, including lands adjacent to the Tidal Area Landfill and Otter Sluice, does not pose a significant or immediate threat to human or ecological receptors, the entire R Area Disposal Site is recommended to be incorporated into a ROD for the R Area Disposal Site. The Froid and Taylor Roads Site and the Wood Hogger Site are also recommended for NFA. Because all three of these sites are not appropriate for further action, no feasibility study is recommended.

Decisions for a CERCLA site, such as the Tidal Area, reflect input by all parties involved in the risk assessment process, including the Navy, EPA, the California Environmental Protection Agency (Department of Toxic Substances Control and Regional Water Quality Control Board), the U.S. Fish and Wildlife Service (USFWS), the California Department of Fish and Game (CDFG), the National Oceanic and Atmospheric Administration, and the public. The Navy recommends that the R Area Disposal Site, the Froid and Taylor Roads Site, and the Wood Hogger Site proceed to a single, NFA ROD to address these three sites.

A summary of the conclusions and recommendations for each Tidal Area site based on the results of the HHRA and the weight-of-evidence approach for evaluating risks to ecological receptors is presented in Table ES-1.



TABLE ES-1

**SUMMARY OF PRELIMINARY RECOMMENDATIONS AND CONCLUSIONS  
FOR REMEDIAL INVESTIGATION**

Site	Human Health Risk Result (RME) <sup>a</sup>	HHRA Risk Drivers	QEA	Preliminary Conclusions
1, Tidal Area Landfill Site	Residential Risk: $9 \times 10^{-5}$ HI: 2	Soil: Arsenic present at ambient levels; benzo(a)pyrene comparable to background levels	The site does not pose an immediate or significant risk to ecological receptors	Results of HHRA and QEA indicate site conditions are protective for intended use of this area. A presumptive remedy to cap the landfill is currently in place.
	Industrial Risk: $1 \times 10^{-5}$ HI: < 1	Soil: Arsenic present at ambient levels		
2, R Area Disposal Site <sup>b</sup>	Residential Risk: $4 \times 10^{-5}$ HI: < 1	Soil: Arsenic present at ambient levels; benzo(a)pyrene and dibenz(a, h)anthracene comparable to background levels	The site does not pose an immediate or significant risk to ecological receptors	Results of HHRA and QEA indicate site conditions are protective for intended use of this area. Navy recommends no further action at the site and a ROD be prepared.
	Industrial Risk: $6 \times 10^{-6}$ HI: < 1	Soil: Arsenic present at ambient level		
	Surface Water: Risk < $1 \times 10^{-6}$ HI: < 1	No risk drivers identified		

TABLE ES-1 (Continued)

**SUMMARY OF PRELIMINARY RECOMMENDATIONS AND CONCLUSIONS  
FOR REMEDIAL INVESTIGATION**

Site	Human Health Risk Result (RME) <sup>a</sup>	HHRA Risk Drivers	QEA	Preliminary Conclusions
9, Froid And Taylor Roads Site	Residential Risk: $3 \times 10^{-6}$ HI: < 1	Soil: Benzo(a)pyrene at background levels; lead exceeds residential PRG	The site does not pose an immediate or significant risk to ecological receptors	Results of HHRA and QEA indicate site conditions are protective for intended use of this area. Navy recommends no further action at the site and a ROD be prepared.
	Industrial Risk: $< 1 \times 10^{-6}$ HI: < 1	No risk drivers identified		
	Surface Water: $5 \times 10^{-5}$ HI: < 1	Surface water: Arsenic		
11, Wood Hogger Site <sup>b</sup>	Residential Risk: $2 \times 10^{-4}$ HI: < 1	Soil: Arsenic present at ambient levels; carcinogenic PAHs comparable to background levels; dioxins and furans	The site does not pose an immediate or significant risk to ecological receptors	Results of HHRA and QEA indicate site conditions are protective for intended use of this area. Navy recommends no further action at the site and a ROD be prepared.
	Industrial Risk: $2 \times 10^{-5}$ HI: < 1	Soil: Arsenic present at ambient levels; benzo(a)pyrene and dibenz(a,h)anthracene comparable to background levels; dioxins and furans		
	Surface Water: Risk $< 1 \times 10^{-6}$ HI: < 1	No surface water risk drivers identified		

TABLE ES-1 (Continued)

SUMMARY OF PRELIMINARY RECOMMENDATIONS AND CONCLUSIONS  
FOR REMEDIAL INVESTIGATION

Site	Human Health Risk Result (RME) <sup>a</sup>	HHRA Risk Drivers	QEA	Preliminary Conclusions
Otter Sluice	None conducted	Not evaluated	The site does not pose an immediate or significant risk to ecological receptors	Results of HHRA and QEA indicate site conditions are protective for intended use of this area. Navy recommends no further action at the site and a ROD be prepared.

Notes:

HHRA Human health risk assessment

HI Hazard index

Navy U.S. Department of the Navy

PAH Polynuclear aromatic hydrocarbon

<sup>a</sup> Risk assessment results are presented only when the risk exceeds 1E-06. The hazard index is the maximum segregated HI. Both surface and subsurface soils were analyzed in the HHRA; the cancer risk and HI values presented in the table are for the greater of the two depth intervals.

<sup>b</sup> No separate IR site has been established for Otter Sluice because it is adjacent to the R Area Disposal Site and the Wood Hogger Site, and because no contamination source has been associated with Otter Sluice.

PRG Preliminary remediation goals  
QEA Qualitative ecological risk assessment  
RME Reasonable maximum exposure  
ROD Record of decision



## 1.0 INTRODUCTION

The U.S. Department of the Navy, Engineering Field Activity West (EFA WEST) is conducting a remedial investigation (RI) at the Tidal Area of the Naval Weapons Station, Seal Beach Detachment (NWS SBD) Concord, California (Figure 1-1). EFA WEST has authorized Tetra Tech EM Inc. (TtEMI) to develop this RI report under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62474-94-D-7609 (CLEAN II), Contract Task Order (CTO) 0217. Work on the tidal area sites was initiated under the CLEAN I contract, Contract No. N62474-88-D-5086, under CTOs 0232 and 0281. Earlier draft versions of this report were prepared by TtEMI, formerly known as PRC Environmental Management, Inc. (PRC), and the CLEAN I team firm, Montgomery Watson.

The purposes of this RI report are to:

- (1) Discuss the environmental investigation process for the following four Tidal Area RI sites;
  - Site 1 - Tidal Area Landfill
  - Site 2 - R Area Disposal
  - Site 9 - Froid and Taylor Roads
  - Site 11 - Wood Hogger
- (2) Provide facility background;
- (3) Describe field investigation activities;
- (4) Identify applicable regulations governing the sites;
- (5) Interpret the geology and hydrogeology;
- (6) Present the nature and extent of chemicals in soil, sediment, surface water, and groundwater;
- (7) Estimate the human health risk and ecological risk;
- (8) Describe the fate and transport of chemicals in the environment; and
- (9) Provide recommendations for the Tidal Area sites based on the findings of this RI.

The locations of the four Tidal Area sites are shown on Figure 1-2. A general site map showing site features is presented as Figure 1-3.

A 1992 site investigation (SI) of the four Tidal Area sites recommended further investigation (International Technology Corp. [IT] 1992). Project plans were developed to conduct further sampling to determine possible contamination at these sites. These plans were implemented during RI field activities (PRC and Montgomery Watson 1994a, 1994b, 1994c; PRC 1995, 1996a; TrEMI 1997, 1998a).

For the purposes of investigating and evaluating risk to human health and ecological receptors, Site 1, the Tidal Area Landfill, is divided into two areas. The first area is the Tidal Area Landfill itself, which lies within the boundary of former waste disposal. The second area lies beyond the area of former waste disposal and is actually a subpart of the R Area Disposal Site. Only the second area, which lies within the R Area Disposal Site, is evaluated in detail in this RI report.

The first area of the Tidal Area Landfill, where waste was dumped, is currently in the record of decision (ROD) phase under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Tidal Area Landfill ROD is expected to be signed before the end of 1999. The ROD documents the selection of a landfill cap as the most appropriate remedial action for the disposal area of the Tidal Area Landfill. The landfill disposal area was not evaluated as a part of this RI because characterizing the landfill contents and evaluating risk to receptors is unnecessary within the boundaries of landfills according to U.S. Environmental Protection Agency (EPA) guidance documents (EPA 1991, 1993a). This area is expected to be capped once the ROD is signed and the detailed design is completed.

For the purposes of this RI report, the Tidal Area Landfill refers to land within the R Area Disposal Site but just outside the Tidal Area Landfill waste disposal area. This perimeter land was investigated in detail to see if toxic chemicals—which are potentially present within the Tidal Area Landfill—have migrated into the R Area Disposal Site.

Because the Tidal Area Landfill is actually part of the R Area Disposal Site, the remedy selection for this area will be documented as the remedy for the R Area Disposal Site. Although the Tidal Area Landfill perimeter area and the R Area Disposal Site are considered separately throughout this report, combining these areas into one site is logical in the ROD phase for three reasons. These include the following: (1) both areas are visually indistinguishable from each other, (2) neither area contains toxic chemicals identified at concentrations that are considered a threat to human health or ecological receptors, and (3) the recommended remedy for both areas (no further action) is identical.

Otter Sluice was never established as a separate installation restoration (IR) site because there is no record of direct contamination spills or releases to Otter Sluice. Otter Sluice was evaluated in this RI as a separate area, based on state and federal regulatory agency comments received after the draft RI was prepared. Additional evaluation of Otter Sluice was performed to evaluate (1) the potential release of contamination into Otter Sluice (2) the potential for exposure of receptors to toxic constituents that may have settled in Otter Sluice from other Tidal Area IR sites. Otter Sluice was evaluated as a potential hazard to animal receptors but was not evaluated from a human health risk standpoint due to the lack of contaminants and the lack of a complete exposure pathway of potential contaminants to humans. Because Otter Sluice was not evaluated as a part of the human health risk assessment (HHRA), Otter Sluice is evaluated in detail in Volume II instead of Volume I of this report. A summary of the ecological conclusions and recommendations for Otter Sluice is presented in Section 9.0 of Volume I of this RI report.

The following introductory sections describe the purpose of this RI report and the report organization.

## **1.1 PURPOSE**

The broad goal of the CERCLA process is to determine whether a site poses a risk to human health and the environment and, if so, to select a remedy that will eliminate, reduce, or control those risks. One of the main steps in this process is the RI/feasibility study (FS). The RI characterizes the environmental conditions at the site. The FS develops and evaluates remedial alternatives using the data collected in the RI. This report presents the results of the RI. The following sections further describe the RI/FS process at NWS SBD Concord and the purpose of this report.

### **1.1.1 The Installation Restoration Program**

CERCLA and the Superfund Amendments and Reauthorization Act of 1986 (SARA) established a series of programs to cleanup hazardous materials disposal sites and release sites nationwide. One of these programs, the Defense Environmental Restoration Program (DERP), is codified in SARA Section 211 (10 United States Code [USC] 2701). The Navy Installation Restoration Program (IRP) is a component of DERP and is designed to identify, assess, and remediate contamination at former hazardous materials disposal sites and release sites that resulted from Navy and Marine Corps activities.

A site qualifies for funds under the IRP depending on when the disposal operations occurred and on the type of waste disposed. The IRP addresses contamination resulting from past, but not current, disposal operations. The IRP is primarily intended to clean up former waste disposal or spill areas that endanger public health, welfare, or the environment. Past waste disposal activities may include such chemicals as polychlorinated biphenyls (PCB); metals; petroleum, oil, and lubricants; pesticides; paints and solvents; and ordnance products. Sites not covered by the IRP are addressed under other Navy programs.

The Navy's IRP follows a process developed by the EPA pursuant to CERCLA to identify, assess, and remediate hazardous waste sites (EPA 1988). The CERCLA process consists of three main activities:

- Preliminary assessment and site inspection
- RI/FS
- Remedial design and remedial action

The first step under CERCLA, a preliminary assessment and site inspection, serves to (1) eliminate from further consideration those sites that do not pose a risk to human health and the environment, (2) determine the need for a removal action, and (3) to score a site using the Hazard Ranking System (HRS). The preliminary assessment relies on existing information about the site, whereas the site inspection involves collecting data for further site characterization.

The second step consists of an RI and, if the site is found to pose a risk to human health or the environment, an FS. The RI involves a more detailed site evaluation to identify the nature and extent of chemicals present, and may include multiple field efforts to collect sufficient data in the most cost-efficient manner possible. The FS uses the information developed in the RI to evaluate remedial alternatives for correcting site problems. The lead agency (EPA is the lead agency for NWS SBD Concord) then identifies the remedial alternative that best meets the requirements of CERCLA and presents that alternative to the public in a proposed plan. Based on comments received from the public, a final remedial alternative is selected and is documented in a ROD.

The third step includes a remedial design and remedial action. The remedial design involves preparing design specifications and drawings to implement the selected remedial alternative. The remedial action refers to actual implementation of the remedy through construction, disposal, or treatment.



A Federal Facilities Agreement (FFA) between the Navy and EPA is currently being negotiated and is expected to be signed before the end of the year. A Federal Facility Site Remediation Agreement (FFSRA) between the Navy and state regulatory agencies was signed on September 29, 1992. The FFA and FFSRA for NWS SBD Concord defines the activities and responsible parties involved in the IRP process at the various sites. These activities are conducted in cooperation and close coordination with EPA, the State of California Department of Toxic Substances Control (DTSC), the San Francisco Bay Regional Water Quality Control Board (RWQCB), the U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration (NOAA), the California Department of Fish and Game, the Contra Costa County Public Health Department, and other appropriate regulatory agencies.

NWS SBD Concord was listed on the federal National Priorities List (NPL) on December 16, 1994. RWQCB originally was the lead regulatory agency for the Tidal Area investigation at NWS SBD Concord under the FFSRA; however, EPA became the lead regulatory agency once NWS SBD Concord became an NPL site. NWS SBD Concord is an active installation and is not slated for closure.

#### **1.1.2 Remedial Investigation Objectives**

The specific objectives of the RI for the four Tidal Area IRP sites at NWS SBD Concord are as follows:

- Characterize the nature and extent of soil, sediment, surface water, and groundwater contamination at each site in order to develop and evaluate effective remedial alternatives.
- Characterize the geology, hydrology, and hydrogeology at the four sites and at the Tidal Area as a whole.
- Identify potential contamination migration pathways and associated receptors for each site, and evaluate the extent, nature, and rates of contaminant migration from each site.
- Gather data for a baseline HHRA and for the qualitative ecological risk assessment (QEA) at the four sites.
- Gather data to support initial FS activities, such as technology screening and treatability studies, conducted concurrently with the RI.

This RI report was prepared with these objectives in mind, in accordance with the revised National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and EPA's guidance for conducting RI/FS under CERCLA (EPA 1988). The data gathered during the RI are used to evaluate whether the

site poses a risk to human health or the environment. If a risk exists, the RI data will be used in the FS process to evaluate remedial alternatives.

## **1.2 REMEDIAL INVESTIGATION PROJECT PLANS**

The SI report proposed recommendations for future work at the NWS SBD Concord Tidal Area sites. These recommendations were the basis for designing the RI at the four Tidal Area sites, which are shown on Figure 1-3. The project plans present the RI that was conducted at the NWS SBD Concord Tidal Area, and are briefly described below (PRC and Montgomery Watson 1994a, 1994b, 1994c; PRC 1995, 1996a; TtEMI 1997, 1998a):

- **Work plan (WP):** The WP describes the proposed implementation of the RI activities from the planning stage to completion of the FS. The WP is the most comprehensive of the project plans, and describes the RI/FS process, site history, settings, and RI objectives. The WP presents the rationale and methodology for conducting the RI, based on a review of the information available for each site. Volume I of the WP describes all of the above information except the proposed work for the QEA, which is presented in Volume II of the work plan.
- **Field sampling plan (FSP):** The FSP, together with the quality assurance project plan (QAPP), comprises the sampling and analysis plan (SAP) and provides guidance for all field work by defining the sampling and data-gathering methods and rationale to be used during site characterization. The FSP also specifically identifies the locations of all proposed soil, sediment, and surface water samples. Investigation-derived waste sampling, management, and disposal issues are addressed in the waste management plan.
- **QAPP:** As the complementary half of the SAP, the QAPP describes the policy, organization, functional activities, and quality assurance and quality control (QA/QC) protocols necessary to achieve the data quality objectives (DQO) dictated by the intended use of the data. In addition, procedures for data validation are discussed in the QAPP.
- **Health and safety plan (HSP):** The purpose of the HSP is to outline the procedures to protect the health and safety of site personnel during RI field activities. Potentially hazardous operations and exposures are identified, and appropriate protective measures are specified in the HSP.
- **Community relations plan (CRP):** The CRP documents the community relations history and the issues of community concern as they relate to RI activities at the sites. In addition, it defines mechanisms for disseminating related information to interested agencies and the community as such information becomes available. The CRP also provides a process for community input into the CERCLA remedy selection process.

This report is divided into three volumes: Volume I provides text, figures, and tables for Sections 1.0 through 9.0. Volume II contains the QEA. Volume III contains the appendices. Subsequent sections of Volume I describe the facility background, environmental setting, geology, and hydrogeology; field activities; applicable regulations and screening criteria; nature and extent of chemicals in soil, sediment, and surface water; potential human health concerns; fate and transport of chemicals; and recommendations. The recommendations of the RI are presented in Section 9.0 of Volume I. The recommendations presented in Volume I are based on the entire RI including the information presented in Volumes II and III. A detailed description of Sections 1.0 through 9.0 of Volume I, Volume II, and Volume III of this RI report follows:

- Section 1.0, Introduction, introduces the project and presents background information.
- Section 2.0, Facility Background and Setting, describes the NWS SBD Concord location, land use and transportation, facility history, current operations, environmental setting, flora and fauna, and site history.
- Section 3.0, Investigation Methods, describes investigation reconnaissance activities; soil, sediment, and surface water investigations; field QA/QC procedures; tidal survey; deviations from the investigation proposed in the FSP; the analytical program; and the data validation process.
- Section 4.0, Laws, Regulations, and Screening Criteria, describes preliminary applicable or relevant and appropriate requirements (ARAR), and screening criteria.
- Section 5.0, Geology and Hydrogeology of the Tidal Area Sites, discusses the geologic and hydrologic findings of the RI field investigations.
- Section 6.0, Chemical Characterization, discusses the chemical findings of the RI field investigations, and presents conceptual models for the Tidal Area sites.
- Section 7.0, Human Health Risk Assessment, presents data evaluation, exposure assessment, toxicity assessment, and risk characterization for the Tidal Area sites.
- Section 8.0, Contaminant Fate and Transport, presents an assessment of the fate and transport of chemicals in the soil, sediment, and surface water at the Tidal Area sites.
- Section 9.0, Conclusions and Recommendations, presents site-specific conclusions and recommendations for each of the four Tidal Area Sites.
- Volume II, Qualitative Ecological Risk Assessment, presents the investigation, evaluation, and recommendations resulting from the QEA conducted at the Tidal Area sites.

- Volume III, Appendices A through U, presents analytical data tables, boring logs, toxicity profiles, preliminary remediation goals (PRG), statistical data summaries, a QC summary report, data validation issues, ecological summary tables, and Navy responses to agency comments on the draft RI report.

## **2.0 FACILITY BACKGROUND AND SETTING**

The following sections describe the location, land use, transportation, facility history, current operations, environmental setting, flora and fauna, and Tidal Area site history of NWS SBD Concord. Physical characteristics of the specific investigation sites, such as geology and hydrology, are discussed in Section 5.0. Contaminant distribution at the sites is discussed in Section 6.0.

### **2.1 LOCATION**

NWS SBD Concord is located in the north-central portion of Contra Costa County, California, about 30 miles northeast of San Francisco. The facility, which encompasses about 13,000 acres, is bounded by Suisun Bay to the north and the City of Concord to the south and west (Figure 1-1). Currently, the facility contains three main separate land holdings: the Tidal Area, the Inland Area, and a radiography facility in Pittsburgh, California. This report discusses the four IRP sites located within the Tidal Area.

The Tidal Area encompasses about 6,800 acres. The Tidal Area boundary is shown on Figures 1-1 and 1-2. Most of the Tidal Area consists of wetlands.

The Inland Area of NWS SBD Concord encompasses about 6,200 acres. The Inland Area is separated from the Tidal Area by the towns of Clyde and Los Medanos Hills. A Navy-owned road and rail line link the two areas. Seal Creek (also known as Mt. Diablo Creek) flows through the Inland Area roughly paralleling Kinne Boulevard into Hastings Slough in the western portion of the Tidal Area, where it drains into Suisun Bay.

### **2.2 LAND USE AND TRANSPORTATION**

Land use in the vicinity of NWS SBD Concord is diverse, characterized by a mixture of industrial and residential areas, rangeland, and open space. The county-protected land use plan is intended to ensure continuing development of each of these four Tidal Area sites (Naval Facilities Engineering Command [NFEC] 1979).

Los Medanos Hills (Figure 1-1) separates the Tidal and Inland Areas of NWS SBD Concord. This land is privately owned and is leased to the Pacific Gas and Electric Company and ranchers for cattle grazing. Fifteen miles southeast of NWS SBD Concord is the 7,004-acre Mount Diablo State Park and State Game Refuge. NWS SBD Concord is bordered on the south by residential sections of the City of Concord. The Concord Pavilion, a public entertainment facility, is located on Kirker Pass Road near

the facility's southern boundary. The City of Concord operates a large water treatment plant and the Mallard Reservoir about 1,500 feet west of Port Chicago Highway.

Land north of State Route 4 (Figure 1-1) and west of NWS SBD Concord is zoned for industrial development. Several industrial firms have located there, particularly along Port Chicago Highway near the main gate of NWS SBD Concord. Tosco Avon Refinery and Monsanto Chemical Company have facilities along Solano Way near Waterfront Road.

Access to NWS SBD Concord is through guarded gates, and private vehicles provide local transportation. No organized public transportation system is available at the station. Access to the Tidal Area is through a gate off Port Chicago Highway west of the main entrance to the Inland Area.

### **2.3 HISTORY**

The NWS SBD Concord Tidal Area stands on a site originally occupied by the Pacific Coast Shipbuilding Company. The original name of the area was Bay Point. The shipping yard occupied the area north of what is now the R Area Disposal Site (Site 2). At that time, Johnson Road was the only major road into the Tidal Area. In 1927, the Navy chose the site for naval ordnance operations because of its remoteness from populated areas and the presence of three major rail lines. In January 1942, construction on the waterfront handling facilities began, and in April, the facility was commissioned as Naval Magazine Port Chicago. The name Bay Point was changed to Port Chicago. Since then, the Inland Area, located in the Diablo Creek Valley, was acquired and linked to the Tidal Area by the Port Chicago and Clayton railroads.

The transformation of the Tidal Area from the time of Navy acquisition to the present has been documented by aerial photographs. Maps based on these photographs are presented as Figures 2-1 through 2-7. The change in site features over time illustrates the surface impact of the Navy activities on the wetlands. In addition, the surface features of the site affect the potential surface and subsurface transport of chemicals from the sites. These site features are discussed in the geology and hydrology, chemical characterization, and fate and transport sections (Sections 5.0, 6.0, and 8.0, respectively).

On July 7, 1944, two munitions ships docked along a pier by the Tidal Area exploded. Both ships and the pier were destroyed, and 320 people were killed. Nearby residents of the town of Port Chicago were injured. To protect the civilian population, Congress gave the Navy the authorization to acquire all land within a 2-mile radius of the loading piers. Between 1968 and 1972, the towns of Port Chicago

and Nichols were purchased and demolished by the U.S. Government to provide a safety zone. The former sites of these two towns are now part of the Tidal Area.

## **2.4 CURRENT OPERATIONS**

NWS SBD Concord is the major naval explosive ordnance transshipment facility on the West Coast. The facility provides storage, maintenance, and technical support for ordnance operations. Most station facilities located in the Tidal Area are dedicated to ordnance operations. The 17,000 linear feet of waterfront contains three explosives-handling piers, a barge pier, lighter moorings, and a tug basin. Barricaded rail car siding, rail car classification yards, and a large unbarricaded truck holding lot are inland from the waterfront area and about 1,000 feet east of the Tidal Area Landfill Site (Site 1).

In addition to the pier facilities, ordnance is handled in the segregation complex (immediately north of the R Area Disposal Site, Site 2) and in two transfer facilities. Most of the land in the Tidal Area is encumbered by Explosive Separation-Quantity Distance (ESQD) arcs required as safety perimeters by ordnance operations. Ten buildings in the Tidal Area are used for inert storage, bulk storage, or general warehousing. Limited public works support facilities and administrative facilities are also present. An additional 1,675 acres are leased for rangeland.

## **2.5 ENVIRONMENTAL SETTING**

Sections 2.5.1 through 2.5.4 describe the regional environmental setting of NWS SBD Concord, including physiography and topography, geology, hydrology, hydrogeology and climate.

### **2.5.1 Physiography and Topography**

Contra Costa County consists of four general physiographic regions: the highlands of the Coast Range, the inter-mountain valleys, the San Francisco Bay depression, and the Sacramento-San Joaquin Delta. The intercoastal highlands (Diablo Range) are smooth rolling hills and relatively rugged mountains ranging from about 100 feet above mean sea level (msl) along the San Francisco Bay depression to 3,849 feet above msl at Mt. Diablo. The inter-mountain valleys and San Francisco Bay depression consist of early flat floodplains and low terraces with gently rolling fans and old terrace remnants adjacent to the uplands. NWS SBD Concord lies about 10 miles west of the confluence of the Sacramento and San Joaquin Rivers. This confluence forms the Delta region, which contains over 600 miles of interconnected and meandering tidal waterways. Most of the low-lying, river-delta lands

have been reclaimed by protective dikes and drainage ways to form islands ranging from 30 to 7,000 acres in size. Drainage from NWS SBD Concord is exclusively into Suisun Bay.

The Tidal Area originally consisted of three distinct land formations: salt wetlands along the shore of Suisun Bay, the upland colluvial slope, and the sandstone hills farthest from the water. A large section of the wetlands was modified by the addition of large amounts of fill material when NWS SBD Concord was originally constructed. Almost all existing Naval facilities were built on these filled areas (IT 1992). Between the Tidal Area and Los Medanos Hills is a band of colluvial slope material that is about 0.5 mile wide. This colluvial slope is the most suitable terrain for development because of its higher elevation and gentle slope. The Los Medanos Hills are characterized by steeply sloping terrain, beginning at the 100-foot elevation and rising to more than 600 feet.

### **2.5.2 Regional Geology**

The information presented in this section is based on data provided in the Tidal Area SI report (IT†1992), geotechnical borings obtained from the Navy, and available published material. The description of bedrock geology is largely derived from a guidebook published by Bray and others (1996).

NWS SBD Concord is located within the geologically complex and tectonically active California Coast Range approximately 30 miles east of San Francisco Bay. The geologic setting of the site is characterized by a blanket of unconsolidated sediments resting on an eroded and deformed bedrock surface, which is cut by faults. The Tidal Area of NWS SBD Concord is located within the southern part of a structural trough that is partially occupied by Suisun Bay (Figure 1-1). The trough is partially filled with a significant thickness of unconsolidated late Pleistocene and Holocene sediments. Glacial advances and retreats during the Quaternary Period have caused sea level fluctuations and changes to the depositional sedimentary environment. Historically, glacial advances caused the sea level to drop 300 to 400 feet below its present level. The drop in sea level resulted in the disappearance of estuarine depositional environments, such as the current Suisun Bay, and the incision of the Sacramento River Valley. In contrast, during times of glacial retreats, such as current glacial conditions, the sea level rose high enough to flood Suisun Bay, forming an estuary. As a result, sediments beneath Suisun Bay consist of estuarine sediments deposited during high sea level stands, alternating with alluvial and fluvial sediments that were deposited during low sea level stands. These Quaternary sediments underlie the Bay Mud and younger alluvium, and outcrop in a few areas in the vicinity of NWS SBD Concord



as shown on Figure 2-8. The depositional environments of the Bay Mud and alluvium are discussed in Section 2.5.3.

The primary bedrock structure at NWS SBD Concord is a layered bedrock block that strikes west-northwest and dips at about 35° to the northeast. Outcrop of this bedrock block forms Los Medanos Hills. The bedrock block is cut by the northwest-trending Clayton Fault, which runs roughly parallel to the base of Los Medanos Hills. Dibblee has interpreted vertical displacement along the Clayton fault.

The bedrock stratigraphic sequence at NWS SBD Concord consists of (in order of decreasing age) the Markley Formation, the Kirker Formation, the Cierbo Formation, the Neroly Formation, Pliocene volcanics, and the Wolfskill and Montezuma Formations.

The Markely Formation is a thick turbidite sequence that consists primarily of marine graywackes and Middle Eocene mudstones. The Markely Formation is about 1,075 meters (3,500 feet) thick and forms many of the hummocky hills visible south of Highway 4 (Los Medanos Hills).

The Kirker Formation is an Oligocene-aged sandstone that unconformably overlies the Markley. The unit consists of a thin basal conglomerate overlain by sandstone that contains increasing amounts of volcanoclastic materials toward the top of the section. At its thickest point, the Kirker Formation is approximately 100 meters (330 feet) thick. The Kirker Formation is not present west of the Kirker Pass Fault.

The Cierbo Formation is a Miocene-aged estuarine sandstone that attains thickness up to 120 meters (400 feet). The Neroly Formation is a dark gray fluvial sandstone and mudstone unit that overlies the Cierbo Formation. The base of the Neroly is well cemented, and the basal sandstone members of the formation produce prominent bluffs. The Neroly Formation attains a thickness of 180 meters (590 feet). The Neroly and Cierbo sandstones are very productive aquifers but produce poor quality water that contains high levels of concentrations of dissolved solids and sulfur compounds.

Late Tertiary volcanism is reflected by two volcanic units at NWS SBD Concord, the Lawlor Tuff and unassigned basaltic lava flows. The Lawlor Tuff consists of a 50 thick 165-foot sequence of rhyolitic breccias and angular fragments of pumice in a pumiceous matrix that unconformably overlies the Neroly Formation. A sample of the Lawlor Tuff collected just east of the tidal area has been dated at 4.1 million years (Pliocene) using potassium-argon dating methods (Wagner and others 1987). The

unassigned lava flows are discontinuous and appear as isolated outcrops. The lava flows have been dated at 4.5 million years, but structural relationships suggest that they may be younger.

The Lawlor Tuff is overlain by a mixed assemblage of weakly indurated, nonmarine claystones, siltstones, sandstones, and pebbly gravels of Pliocene and Pleistocene age. This poorly stratified unit comprises the Wolfskill Formation and the Montezuma Formation, which are known locally as the Tehama Formation (Dibblee 1980). The Wolfskill Formation is present along the northeastern edge of Los Medanos Hills. The total thickness of these formations at NWS SBD Concord is not known.

Several active or potentially active major faults are present in the vicinity of NWS SBD Concord and are shown on Figure 2-8. The Concord fault is a northwest-trending, right-lateral, strike-slip fault located about 1 mile southwest of the Inland Area of NWS SBD Concord. The fault is interpreted to be the northward extension of the Calaveras Fault, which is a major branch of the San Andreas Fault system (La Volette and Wigginton 1983; Weaver and Hill 1979). The fault displays surface creep (Sharp 1973; Galehouse and others 1982) and reportedly experienced a magnitude 5.5 earthquake in October 1955. The Clayton Fault lies within the Inland Area of NWS SBD Concord near the southwestern base of Los Medanos Hills. The fault generally strikes northwest, dips northeast, and is interpreted to have significant dip slip separation (Dibblee 1980, 1981; Sims and others 1973). No major earthquakes are known to have occurred on the Clayton Fault; however, this fault has been interpreted to be the northwestern extension of the Greenville Fault, which has shown geomorphic evidence of Holocene displacements and experienced an earthquake with surface rupture in the eastern part of the Livermore Valley in January 1980 (Earth Science Associates 1982). The Antioch Fault is a northwest-trending fault located about 10 miles east of NWS SBD Concord. No documented significant earthquakes have occurred on the fault; however, the 1889 Collinsville earthquake may have produced surface rupture in the City of Antioch (Topozada and others 1981).

### **2.5.3 Regional Hydrology and Hydrogeology**

The generalized regional and local hydrologic and hydrogeologic environments of the Tidal Area at NWS SBD Concord are discussed in this section. The hydrologic data are derived from various subsurface field investigations. The hydrogeologic data are based on geologic maps, information from various subsurface field investigations in the Suisun Bay and Carquinez Strait area, and available published material.

### **2.5.3.1 Hydrologic and Hydrogeologic Setting**

Groundwater conditions in the Tidal Area sites are detailed in a technical memorandum entitled "Confirmation Groundwater Sampling in the Tidal Area Sites" (TiEMI 1998b), and are briefly summarized in this section.

The Tidal Area of NWS SBD Concord is characterized by an irregular piezometric surface and very thin (or absent) vadose zone. Surface water features in the Tidal Area act as local groundwater recharge and discharge zones. Regionally, groundwater flows northward from Los Medanos Hills through the low-lying Tidal Area toward Suisun Bay. Surface water flows northward from Los Medanos Hills toward Suisun Bay in natural creeks, artificial ditches, canals, and culverts.

Groundwater at the NWS SBD Concord Tidal Area Sites occurs in a shallow, unconfined water-bearing zone that is predominantly composed of silty clays. As NWS SBD Concord developed, site drainage was modified by digging drainage channels and filling both natural and manmade channels with sandy fill materials and silty clays, leaving a complex subsurface characterized by silty clays and linear bodies of sandy fill material.

Tidally influenced natural sloughs in the lowlands near Suisun Bay convey Bay water to and from the Tidal Area. Hastings Slough, located in the western portion of the Tidal Area, extends from Suisun Bay to the Tosco Avon Refinery in Martinez, California. Mount Diablo Creek (also called Seal Creek within the NWS SBD Concord property) drains into Hastings Slough. Belloma and Cunningham Sloughs are two smaller sloughs in the central portion and east of the Tidal Area.

Otter Sluice is manmade channel that flows along the western and southern sides of the Tidal Area sites at NWS SBD Concord. The sluice provides surface water drainage from the R Area Disposal and Wood Hogger Sites to Suisun Bay.

Water levels in the natural and manmade channels fluctuate in response to tides in Suisun Bay. A tidal influence study has shown that groundwater elevations at NWS SBD Concord are locally influenced by tidal fluctuations in Otter Sluice and the natural sloughs (Section 5.2.1).

A network of manmade channels drains surface water from the Tidal Area sites. As discussed in Section 5.2, the channels strongly affect the dynamics of surface water movement at the site. Otter Sluice is the main surface water channel at the Tidal Area sites. Before the Navy acquired the Tidal

Area, a manmade drainage channel or sluice drained what is now the Tidal Area Landfill and the R Area Disposal Sites (Figure 2-1). The southern and eastern branches of the old sluice were backfilled prior to 1950, and the western branch was incorporated into Otter Sluice after the Navy acquired the Tidal Area (Figures 2-2 through 2-6). A natural slough meandered through the Tidal Area sites prior to Navy ownership and was partially backfilled before 1939 (Figures 2-1 through 2-6).

Exploratory borings drilled during the groundwater confirmation study (TtEMI 1998b) have shown that the backfilled manmade sluice and natural channels are not continuously filled with coarse-grained fill material, and that the water table is below the base of the backfill during the dry season. Therefore, it is considered unlikely that the filled manmade sluice and filled slough are hydrologically connected with Suisun Bay.

Groundwater is a few feet below grade throughout the year. Groundwater elevations are higher at the margins of the Tidal Area sites, indicating that groundwater flows from the edges of the Tidal Area sites toward the center. During both wet and dry seasons, groundwater flows radially toward depressions in the water table in the R Area Disposal Site. Groundwater does not appear to discharge to Suisun Bay via subsurface flow or groundwater and surface water interaction, although tidal influence studies have shown that limited groundwater and surface water interaction occurs along a narrow strip adjacent to Otter Sluice.

The most probable cause of the closed depressions in the water table at the center of the R Area Disposal Site is the alteration of the site by placement of fill, which prevents some of the surface water drainage from the area during low tides. Because water gets trapped in the area, it is subject to evaporation. Surface water evaporation and evapotranspiration of groundwater from wetland plants removes water from the area. The phenomenon of evapotranspiration from wetland plants is known as phreatophytic pumping. Phreatophytic pumping is a common feature of wetlands in semiarid climates that allows groundwater to discharge directly to the atmosphere (Freeze and Cherry 1979). As evaporation and evapotranspiration occur, only water vapor is lost to the atmosphere, and dissolved solids are left behind. Therefore, residual surface water and groundwater become enriched in dissolved solids. Evaporation and phreatophytic pumping that account for the elevated dissolved solids concentrations that have been measured in the R Area Disposal Site.

### 2.5.3.2 Lithology and Distribution of Hydrogeologic Units

Four geologic cross sections were constructed to evaluate the hydrogeology of the Tidal Area. The plan view locations of the cross-section transects are shown on Figure 2-9. In general, five major hydrogeologic units are identified within about 100 feet beneath the Tidal Area. The five units are (1) artificial fill, (2) Bay Mud (clay with sand and peat stringers), (3) Yerba Buena Mud (clay with minor sand lenses), (4) recent alluvium (including sands, silts, and clays), and (5) fluvial or estuarine sediments (predominantly micaceous sand). The composition of the artificial fill and sediments, relative thickness, and distribution of each unit are described below.

#### Artificial Fill

Artificial fill has been used throughout the Tidal Area to construct road and railroad beds, channel levees, structural pads, and protective revetments, and to backfill sections of the natural sloughs and artificial sluices. Approximately one-half of the Tidal Area is overlain by fill material. Because the original surface of the tidal marsh was probably 2 to 3 feet above msl, almost all of the material that is currently elevated more than 2 to 3 feet above msl is likely to be fill material. Fill material underlies all of the roads, railroad tracks, and buildings near the Tidal Area sites and much of the Wood Hogger Site. The fill material is typically a mixed lithology that contains varying proportions of clay, silt, sand, and gravel. Wood chips were used as fill material over large portions of the Wood Hogger Site. Clean gravels were imported and used as fill in some areas. Artificial fill materials consisting of soil, household refuse, facility waste, construction debris, and metal debris have been detected locally in the Tidal Area sites. Artificial fill attains a maximum thickness of approximately 30 feet at the explosion deflection berms. The nature and extent of artificial fill at the Tidal Area sites is discussed further in Section 5.0.

#### Bay Mud

Bay Mud is currently being deposited within the San Francisco Bay estuary system. These deposits typically consist of three different lithologies:

- Silty Clay - Silty clay is the predominant lithology of the Bay Mud. Bay Mud silty clays contain organic matter and are typically dark gray to black, soft to medium stiff. These silty clays typically have very low permeabilities and tend to retard the migration of groundwater. Permeabilities of the Bay Mud typically range from  $10^{-5}$  to  $10^{-7}$  centimeters per second (cm/s).

- **Peat** – Some facies of the Bay Mud contain appreciable amounts of peat, which is composed of partially decayed plant material deposited in a marsh environment. The hydrogeologic properties of the peat-rich portions of the Bay Mud vary with the amount of clay present in the peat. In areas where the peat contains little or no clay, it normally has a relatively high permeability and commonly acts as a preferred path for groundwater movement.
- **Sand** – Some portions of the Bay Mud consist of fine- to coarse-grained sand lenses that were deposited in beach areas or in the channels of streams or rivers near the edge of the Bay. The sand bodies within the Bay Mud typically have relatively high permeabilities and could act as preferred pathways for groundwater movement. However, the sand bodies are not typically laterally extensive.

Stratigraphic relationships shown in the geologic cross sections (Figures 2-10 through 2-13) indicate that the silty clay facies of the Bay Mud is the predominant lithology observed within the Tidal Area. The predominance of silty clay is consistent with expected conditions because the Tidal Area is located in a low-energy aquatic environment at a distance from the high-energy environment of the main channel through Suisun Bay. Cross sections across the Tidal Area show that the Bay Mud, with occasional peat lenses, is the dominant lithology on the western portion of the Tidal Area. The eastern portion of the Tidal Area is predominantly peat-rich, and sand lenses are observed in a few places.

Based on available borehole data, the Bay Mud reaches a maximum thickness of about 40 feet in the northern part of the Tidal Area, as shown on Figures 2-10 and 2-11, and thins southward toward Los Medanos Hills. In general, the Bay Mud is absent in the southern part of the Tidal Area.

### **Yerba Buena Mud**

The Yerba Buena Mud (commonly called Older Bay Mud) typically consists of a medium stiff to very stiff clay that is gray, blue, or green in color, it contains significant organic matter (Sloan 1992). The Yerba Buena Mud was deposited during the last interglacial period of high sea level between about 120,000 and 125,000 years ago in the estuary that existed before the current San Francisco Bay (Sloan 1992). The Yerba Buena Mud generally acts as an aquitard and is laterally extensive due to deposition in a large estuary.

Previous studies by Treasher (1963) show that the Yerba Buena Mud is present at depths between 20 and 40 feet below msl in the northern part of NWS SBD Concord. The Yerba Buena Mud varies from a maximum thickness of about 50 feet in the vicinity of Pier 4 to about 10 feet in the vicinity of Pier 2 locally it contains silty or clayey lenticular sands that are typically less than 5 feet thick.

The distribution of the Yerba Buena Mud inland from Suisun Bay is shown on Figures 2-10 through 2-13. The Yerba Buena Mud appears to be absent at the western and southern portions of the Tidal Area where it is replaced by very stiff to medium stiff, predominantly brown and yellow-brown clays locally interbedded with thin sands. These brown and yellow-brown clays are interpreted to be alluvial in origin or may represent a localized facies change within the Yerba Buena Mud. The depositional relationship between the Yerba Buena Mud and the alluvial clays and silts is not known.

### **Alluvium**

Brown and yellow-brown clays and thin interbedded fine-grained alluvial sands are present at the southern and western portions of the Tidal Area, and probably represent alluvium originating from the surrounding hills. The alluvium contains sparse organic matter and has a relatively low permeability. Sands in these alluvial deposits are typically interbedded at multiple horizons with clay or silt beds. Locally, the clay and silt beds are absent, providing pathways for groundwater migration from shallow to deeper sand horizons.

The Tidal Area cross sections show a stiff, yellow-brown to brown clay at elevations between about 10 feet above to 60 feet below that is interpreted to be alluvial clays and silts. Borehole data indicate that the thickness of the alluvial clays and silts varies from about 10 feet to 70 feet. Borings did not penetrate beyond the bottom of the alluvium; therefore, the maximum thickness of alluvium is unknown. The interbedded alluvial sands vary from a maximum thickness of about 5 feet near the Los Medanos Hills to about 1 to 2 feet in various sand stringers within the alluvial clays and silts.

### **Fluvial or Estuarine Sediments**

A thick sand unit is present beneath both the Yerba Buena Mud and the alluvium below an elevation of approximately 50 to 70 feet below msl (Figures 2-10 through 2-13). This sand is typically brown or gray-green in color, is fine- to medium-grained, and locally contains sparse gravels. Data from boring logs identify the unit as both a well and poorly sorted micaceous sand with thin interbedded clay strata. Borehole logs indicate that a clay stringer exists within the sand at a depth of about 85 feet below msl in the vicinity of Pier 2 (Woodward-Clyde Consultants 1978a, 1978b). The maximum observed thickness of the sand is 60 feet; however, the bottom of the sand was not encountered.

The presence of a significant percentage of mica suggests that the source of the sand is the granitic rocks of the Sierra Nevada. Assuming this interpretation is accurate, the sand would have been

deposited by the Sacramento River rather than by local streams. The lateral continuity and thickness of the unit also suggest that the sand is an estuarine fluvial sediment that was deposited by the Sacramento River. The sand may have been deposited in an environment similar to that currently found in the main channel of Suisun Bay that existed during the early stages of the sea level rise, after the last period of glaciation and just before deposition of the Yerba Buena Mud.

As demonstrated from borehole data, the estuarine sands are laterally extensive beneath the Tidal Area. The top of the sands is typically encountered about 30 to 70 feet below ground surface (bgs). The depth of the estuarine sands is greater than 100 feet bgs. The estuarine sands are typically separated from the shallow surficial deposits near the tidal area sites by a 40- to 60-foot-thick alluvial silt and clay sequence and an additional 10 to 15 feet of Bay Mud silty clays.

#### **2.5.3.3 Surface Water Hydrology**

The large-scale physical modifications of the Tidal Area have created a complex hydrological environment, as presented in the following section. The Tidal Area physical environment consists of low-lying areas interrupted by elevated features constructed of artificial fill, such as levees, road beds, building pads, and disposal areas. These elevated features act as barriers to surface flow and create closed basins with limited surface water drainage pathways. Except for the Tidal Area Landfill, surface water is present at all sites during the rainy season. Surface water is also present in some areas of the R Area Disposal and the Wood Hogger Sites during the dry season.

Three natural surface water bodies are located within or adjacent to the Tidal Area at NWS SBD Concord: Suisun Bay, Hasting Slough, and Belloma Slough (Figure 1-2). Suisun Bay is located immediately north of the four Tidal Area sites under investigation. The distance between the Bay and the Tidal Area sites ranges from 550 feet (R Area Disposal Site) to 3,000 feet (Wood Hogger Site). Hasting Slough is located 2,200 feet west of the R Area Disposal Site and Belloma Slough is 3,300 feet east of the Froid and Taylor Roads Site. Hastings Slough and Belloma Slough are not connected to any drainage from the four sites and were not investigated as part of this RI. Prior to Navy ownership, a natural slough meandered through all four Tidal Area sites (Figure 2-1). Portions of the slough were filled, and the direct connection of the slough to Suisun Bay was severed when Navy roads and facilities were constructed in the Tidal Area at NWS SBD Concord: Suisun Bay, Hasting Slough, and Belloma Slough (Figure 1-2). Suisun Bay is located immediately north of the four Tidal Area sites under investigation. The distance between the Bay and the Tidal Area sites ranges from 550 feet



(R Area Disposal Site) to 3,000 feet (Wood Hogger Site). Hasting Slough is located 2,200 feet west of the R Area Disposal Site and Belloma Slough is 3,300 feet east of the Froid and Taylor Roads Site. Hastings Slough and Belloma Slough are not connected to any drainage from the four sites and were not investigated as part of this RI. Prior to Navy ownership, a natural slough meandered through all four Tidal Area Sites (Figure 2-1). Portions of the slough were filled, and the direct connection of the slough to Suisun Bay was severed when Navy roads and facilities were constructed.

Otter Sluice, located along the western boundary of the Tidal Area sites, empties into Suisun Bay near the northwest corner of the R Area Disposal Site. Otter Sluice was constructed to drain water from the wetlands to Suisun Bay. Otter Sluice formerly bounded the western, southern, and eastern perimeter of what is now the R Area Disposal Site and passed through the current location of the Tidal Area Landfill Site. During construction of NWS SBD Concord, the portions of the sluice that previously bounded the south and east perimeter of the R Area Disposal Site were back-filled and the sluice was eventually rerouted around the southwest perimeter of the Wood Hogger Site and the R Area Disposal Site, as shown on Figures 2-3 and 2-6.

Otter Sluice is fitted with a tidal gate at the point where the sluice enters Suisun Bay. The tidal gate is a one-way flow gate designed to allow water to drain from the sluice during low tides but to prevent water from flooding the sluice during high tides. At this time, the tide gate leaks and is therefore only partially effective at preventing high tides from flooding water into Otter Sluice. The tide gate functions properly when there is a low tide in Suisun Bay and the flap valve opens to drain Otter Sluice of rainwater runoff and/or high tide water that has leaked into Otter Sluice from the tide gate.

Surface water from the R Disposal Area site drains to Otter Sluice via two culverts that run underneath Baker Road at the western boundary of the R Area Disposal site. During high tides, surface water from Otter Sluice enters and drains from the R Area Disposal site through the two culverts. During extreme tidal events (for example, when spring tides coincide with storms), surface water from Otter Sluice flows overland across Baker Road into the R Disposal Area site and subsequently drains into Otter Sluice through the two culverts. Surface water exchange between the R Area Disposal Site and Otter Sluice is most prevalent during rainy season. In fact, during the dry season tidal inundation of the R Area Disposal site is limited to a small wetland near the western boundary of the site.

Surface water from Otter Sluice also enters the northwest and south portions of the Wood Hogger Site. These areas have low elevations and form semi-permanent wetlands, with water level variations that

mimic those in Otter Sluice. Otter Sluice is not directly connected with the Froid and Taylor Roads site, but water flows from the sluice into the site during extreme wet season tidal events.

#### **2.5.3.4 Hydrogeology of the Tidal Area**

The hydrogeology of the Tidal Area of NWS SBD Concord is characterized by a thick accumulation (about 30 to 80 feet) of low-permeability clays and silts overlying a relatively coarse-grained, higher-permeability sand layer.

The low permeability clays and silts consist of several units, including the Bay Mud, the Yerba Buena Mud, and the alluvial clays and silts. Interpretation of data from geologic logs suggests that the Bay Mud, Yerba Buena Mud, and alluvial clays and silts form a laterally continuous, relatively thick aquitard. The Bay Mud is the uppermost unit of the aquitard. In the western portions of the Tidal Area, the Bay Mud contains localized horizons peat. In the eastern portions of the Tidal Area, the Bay Mud is richer in peat and presumably more permeable. The lower unit of the aquitard is composed of the Yerba Buena Mud that grades laterally into alluvial clays and silts.

A laterally continuous and relatively thick coarse-grained sand layer underlies the aquitard. This unit is interpreted to be fluvial or estuarine in origin and was deposited in an ancient channel of the Sacramento River. Groundwater quality in the fluvial or estuarine sands would not be affected by potential shallow contamination in the Tidal Area of NWS SBD Concord because groundwater in the overlying aquitard is expected to have slow vertical groundwater flow rates and high rates of natural attenuation due to the high organic carbon content of the soil.

#### **2.5.4 Climate**

Contra Costa County normally experiences dry, warm summers and cool, moderately wet winters. The mean annual precipitation for NWS SBD Concord is 14 inches (Ecology & Environment [E&E] 1983). As in most of northern California, about 84 percent of the rainfall occurs from November through March. Throughout the region, rainfall may vary from 13 inches in the eastern portion of Contra Costa County to over 30 inches on the upper slopes of Mt. Diablo.

The average local temperature varies from 45 °F in January to 75 °F in August. Record highs and lows of 106 °F and 16 °F have been recorded near NWS SBD Concord.

Prevailing winds blow from the west through the wind gap formed at the Carquinez Strait. As a result, the Pacific Ocean and Suisun Bay have a moderating effect on the microclimate of NWS SBD Concord and the surrounding vicinity. These westerly winds are particularly dominant during the summer months and minimal from November through February. Wind directions and speed are monitored at a Pacific Gas and Electric (PG&E) power plant in Pittsburg, a few miles east of the facility. The wind blows from southwest to west-northwest at a mean wind speed of 12 miles per hour (mph) 65 percent of the time.

The geographic and urban settings of NWS SBD Concord make the area prone to urban air pollution. Temperature inversion (an increase in ambient temperature with altitude) is a common occurrence. Temperature inversion prevents airborne pollutants from dispersing vertically into the upper atmosphere, causing concentrations at ground level to rise. The most common pollutants are sulfur dioxide, carbon monoxide, and particulates. Contra Costa County does not meet federal Air Quality Act guidelines for carbon monoxide, particulates, and opacity (haze effect).

## **2.6 TIDAL AREA FLORA AND FAUNA**

A complete discussion of the ecological and biological resource information related to the NWS SBD Concord Tidal Area sites is provided in the QEA, Volume II of this report.

## **2.7 TIDAL AREA SITE HISTORIES**

Mosquito abatement activities at the Tidal Area sites are conducted by the Contra Costa County Mosquito Abatement District-Vector Control (CCCMADVC). These mosquito abatement activities have been conducted since the 1930s; however, records are unclear as to the exact activities and chemicals that have been used. The Navy was involved in earlier abatement activities, but no information is available as to the specific nature and extent of the Navy's activities.

The CCCMADVC currently uses a petroleum-based product that is commercially available under the trade name Golden Bear 1111. The product material safety data sheet describes the material as a petroleum hydrocarbon product containing hydrotreated light naphthionic distillate. CCCMADVC personnel describe the product as diesel or kerosene with the volatile components removed (PRC 1996b). The product is applied to surface water bodies at a rate of about 5 gallons per acre to control mosquito infestation. This product has been applied to standing water in the Tidal Area for the last 8 to 10 years in quantities determined by the development stage and intensity of mosquito larvae

infestation. CCCMADV personnel indicated that the dry portions of the Tidal Area are never sprayed; however, wet, mosquito-producing areas are sprayed once or twice a year to every other week.

This section describes the four sites, discusses their operational history, and summarizes results of previous investigations.

### **2.7.1 Site 1: Tidal Area Landfill Site**

The Tidal Area Landfill Site is shown on Figure 1-3. This section presents the history of operations at the Tidal Area Landfill Site and the results of previous environmental investigations.

#### **2.7.1.1 Site Description and Operational History**

The Tidal Area Landfill Site is located along the western side of Johnson Road, just north of Froid Road (Figure 1-3). The landfill covers about 13 acres and reportedly contains about 33,000 tons of waste (IT 1992). The landfill served as the major disposal area for NWS SBD Concord from approximately 1944 to 1979. Historical aerial photographs indicate that based on the growth of the landfill perimeter, most of the waste was deposited in the landfill between 1959 and 1974. Household garbage from NWS SBD Concord and surrounding communities was disposed of at the landfill. In addition, the landfill reportedly received solvents, acids, paint cans, creosote-treated timbers, asphalt, concrete, asbestos, and ordnance materials, including inert munitions (E&E 1983). Shipboard wastes and the tritanol filler from one 750-pound general-purpose bomb are reported to have been buried in the landfill (E&E 1983).

Historical photographs indicate that the Tidal Area Landfill was created by the progressive disposal of soil and debris outward from Johnson Road. The soil and debris was placed on native soil; apparently no excavation activities were conducted prior to waste disposal. A waste thickness of up to 10 feet was estimated from topographic evaluation; however, the waste may be unevenly distributed, and the undocumented ratio of waste to soil cover in the fill may be variable (IT 1992). There is no record of the degree of landfill subsidence due to consolidation or displacement of the underlying Bay Mud. The origin of the soil cover is unknown. Presently, the edge of the landfill along Johnson Road is bordered by a fence. The surface of the landfill has a soil cover, and metal and wood debris protrude from the surface. Animal burrows and differential subsidence have resulted in a highly uneven surface.

### **2.7.1.2 Results of Previous Investigations**

The following sections discuss the results of previous investigations at the Tidal Area Landfill Site.

#### **Initial Assessment Study**

E&E conducted an initial assessment study (IAS) at the site in 1983. The IAS consisted of a historical records search, a visual inspection of the site, and interviews with NWS SBD Concord personnel. Based on the historical information, E&E recommended the site for further study (E&E 1983).

#### **Site Investigation**

IT conducted the field SI of the Tidal Area Landfill Site from April 1988 to January 1991 and produced an SI report of the Tidal Area (IT 1992). The purpose of the SI was "to confirm or deny the presence of contamination, and to make a preliminary evaluation of potential risk to human health and the environment, and to collect data to characterize potential contamination for initiation of the RI/FS, and remedial alternatives, if warranted" (IT 1992). Based on the site history, the following chemicals were determined to be of concern: volatile organic compounds (VOC), semivolatile organic compounds (SVOC), organochlorine (OC) pesticides and PCBs, inorganics, explosive constituents, and total organic carbon (TOC). Groundwater, surface water, soil, and sediment samples were collected at the Tidal Area Landfill. The Tidal Area Landfill Sites boundary defined in the SI report, was larger than the current site boundary shown on Figure 1-3. As a result, many of the SI Tidal Area Landfill Site sampling locations are located within the currently defined R Area Disposal Site boundary.

Much of the analytical data obtained during the SI were qualified as "estimated" according to IT review procedures and protocols. Data qualified as estimated indicated that the reported concentration was estimated and not definitive. The common qualifier "J" indicating that a result was estimated, was assigned to all types of quality control problems, and did not identify whether the problem was a result of interferences in the analytical measurements or from chemicals detected in QA/QC samples. In addition, IT did not evaluate whether the chemicals detected were actually present in the samples below the quantitation limit or resulted from laboratory or sampling contamination. Furthermore, during the limited confirmation sampling (CS) performed by PRC in 1992, most of the "J"-qualified detected chemicals reported by IT were not detected. This result indicates that most of the chemicals qualified as "J" were likely due to laboratory or sampling contamination. Because IT qualified the SI data in this

manner, it is only of qualitative use. The SI data is summarized below, and is not used in the HHRA calculation presented in Section 7.0.

Seven shallow monitoring wells(14 to 18 feet bgs) were installed in the R Area Disposal Site around the perimeter of the Tidal Area Landfill Site during the SI. Groundwater from the wells was sampled for four quarters (April-May, July, and October 1990, and January-February 1991). During the four quarters of sampling, 11 SVOC were detected in the groundwater at estimated concentrations up to 59 micrograms per liter ( $\mu\text{g/L}$ ). Nine of the 11 SVOC were detected only once and mostly during the first quarter of sampling. Four of the six inorganics detected were at concentrations greater than ambient values, which were established by IT using samples collected off site. Except for zinc, these inorganics were found in most of the wells surrounding the landfill. Zinc was found only in the three wells along the eastern boundary of the landfill (IT 1992).

Surface water samples were collected from two locations adjacent to the landfill's western side during April 1988, May 1989, and April 1990. Surface water samples were filtered with a 0.45 micron filter prior to analysis for metals. In April 1988, concentrations of iron and manganese were greater than concentrations during subsequent sampling events because of the low pH of the surface water (IT 1992). In April 1988, surface water pH values from 1.6 to 2.5 were measured in ephemeral pools. The decrease in pH was attributed to the evaporation and accumulation of salts and infrequent flushing of the surface water at those two locations (IT 1992).

Twenty-five borings were drilled and sampled during September and November 1989 in and around the Tidal Area Landfill Site. Sixty-two soil samples were collected at depths ranging from 0.2 to 10 feet bgs. Thirty-one organic compounds were detected in the soil at the Tidal Area Landfill Site. These organics were primarily VOCs and SVOCs, although the pesticide dieldrin (an estimated 34 micrograms per kilogram [ $\mu\text{g/kg}$ ]), the PCB Aroclor-1260 (an estimated 1,800  $\mu\text{g/kg}$ ), and the nitroaromatic explosive compound nitrobenzene (an estimated 1.1  $\mu\text{g/kg}$ ) were detected in single, separate samples. Six VOC, 1,1,1-trichloroethane (TCA), 2-butanone, acetone, carbon disulfide, methylene chloride, and toluene, were detected at estimated concentrations ranging from 1 to 1,600  $\mu\text{g/kg}$ . Most of these compounds were detected in the central and northwestern portions of the landfill. TCA and toluene were detected at concentrations ranging from 1 to 25  $\mu\text{g/kg}$  in soil from the central and southern portions of the landfill. Twenty-two SVOC were detected; the highest concentrations were in samples from the northwestern and southern edges of the landfill and in the central portion of the landfill. Phthalates were detected in samples collected along the northwestern

edge of the landfill, and polynuclear aromatic hydrocarbons (PAH) were detected along the southern edge and central portion of the landfill. Seven inorganics were detected at concentrations above the IT ambient values. Six of these inorganics were found in samples from the western portion of the landfill. Lead was found in samples from the central and eastern portions of the landfill.

In April 1990, four sediment samples were collected from two low-lying areas adjacent to the southwestern corner of the landfill, near the surface water sampling locations. VOC and inorganics were the only chemicals detected in the sediments. Six VOC were detected in these samples; however, all compounds except total xylenes (an estimated 4 µg/kg) and carbon disulfide are common laboratory contaminants; or carbon disulfides, which occurs naturally in bay environments. Arsenic and mercury were detected at concentrations above the IT ambient concentration ranges.

### **Confirmation Sampling**

The purpose of the CS was to confirm the presence of chemicals detected during the SI and to evaluate the laboratory practical quantitation and detection limits that were achievable for soil and water samples. Samples collected during the CS conducted by PRC in 1993 consisted of one soil sample from the northwestern edge of the landfill, two groundwater samples from wells east (TLWMW001) and north (TLWMW003) of the landfill, and one sediment sample southwest of the landfill. No VOCs or SVOCs were detected in these samples.

## **2.7.2 Site 2: R Area Disposal Site**

The location of the R Area Disposal Site is shown on Figure 1-3. This section presents the history of operations at the R Area Disposal Site and the results of previous environmental investigations.

### **2.7.2.1 Site Description and Operational History**

In 1939, prior to Navy ownership, a meandering slough trending from east to west flowed across the wetlands and marsh lands of the present R Area Disposal Site. The slough also flowed through the present Froid and Taylor Roads and the Wood Hogger Sites of the Tidal Area (Figure 2-1). A manmade sluice was constructed to channel water from the R Area Disposal Site to Suisun Bay. During the construction of NWS SBD Concord, the sluice, now known as Otter Sluice, was backfilled and rerouted around the Wood Hogger Site and the R Area Disposal Site (Figures 2-3 and 2-6).

From the late 1940s until about 1976, the area adjacent to the eastern side of Baker Road, between the Segregation Area (R Buildings) along Froid Road and the Inert Storage Area (S Buildings) along Pickett Road, was used for the disposal of materials generated during the segregation of conventional munitions returned from Pacific operations (Figure 1-3) (E&E 1983). The term "segregation" refers to a process of grouping and repackaging munitions, rather than disassembling the munitions themselves. Typical wastes associated with munitions segregation are expected to include wood packing crates, munitions containers, steel banding, paint waste, and wood debris.

The area used for disposal was named the R Area Disposal Site and was reported in the IAS to be a 10-foot wide, 5-foot deep strip of debris along the east side of Baker Road (E&E 1983). It appears that the segregation waste was actually disposed of in small, isolated piles of debris rather than as a continuous 5-foot-deep strip. During the RI, it was observed that the segregation waste included metal munitions casings and cans that were located on the ground surface and submerged beneath the water along Baker Road. Piles of asphalt paving and metal debris (mattress springs) were also present on the ground surface. Metal munitions containers and debris were also observed along the south side of Pickett Road.

In order to investigate the entire area of potential contamination, the R Disposal Area Site boundary was enlarged during the planning of the RI. The revised R Disposal Area Site encompasses the entire wetland area bounded by Baker Road, Pickett Road, Johnson Road, and Froid Road, up to the western boundary of the Tidal Area Landfill Site (Figure 1-3).

#### **2.7.2.2 Results of Previous Investigations**

The following sections discuss the results of previous investigations at the R Area Disposal Site.

##### **Initial Assessment Study**

E&E conducted the IAS at the site in 1983. The IAS consisted of a historical records search, a visual inspection of the site, and interviews with NWS SBD Concord personnel. Based on the historical information, E&E recommended the site for further study (E&E 1983).

##### **Site Investigation**

IT conducted an SI at the R Area Disposal Site in 1992 and presented the results in an SI report of the Tidal Area (IT 1992). Based on the history of the R Area Disposal Site, the following chemicals were



determined to be risk drivers: VOC, SVOC, OC pesticides and PCBs, inorganics, and explosives. Groundwater, surface water, soil, and sediment samples were collected at the site. The SI data qualifier problems described in Section 2.7.1.2 are also applicable to the R Area Disposal Site. Due to the extensive use of data qualifiers, the SI data is of qualitative use only and is not used in the HHRA calculation (Section 7.0).

During the SI, seven shallow monitoring wells were installed around the perimeter of R Area Disposal Site at depths ranging from 14 to 22 feet bgs. The groundwater was sampled for four quarters (April-May, July, and October 1990, and January-February 1991). During the four quarters of sampling, five SVOC were detected in the groundwater at estimated concentrations of less than 230  $\mu\text{g/L}$ . During the first quarter of sampling, 2-nitroaniline and n-nitroso-di-phenylamine were each detected at estimated concentrations of up to 11  $\mu\text{g/L}$  in groundwater collected from a well in the southeastern portion of the site. Phthalates were detected in water collected from two widely separated wells during three quarters at concentrations up to 34  $\mu\text{g/L}$ . During the first quarter of sampling, the pesticide aldrin was detected at 0.15  $\mu\text{g/L}$  (estimated) in samples collected from a well in the northeastern portion of the site. Some inorganics were present at concentrations above the IT estimated ambient concentrations. Except for zinc, these inorganics were detected in groundwater samples collected from wells located along the western site boundary. Zinc was found in all groundwater samples collected in the R Area Disposal Site.

A total of 18 surface water samples were collected in April 1988, May 1989, and April 1990 from six locations around the site perimeter. Five SVOC, including phthalates, PAHs, and n-nitroso-di-phenylamine, were detected in the surface water along the western side of the site at concentrations up to 15  $\mu\text{g/L}$  (estimated). Surface water samples were filtered with a 0.45 micron filter prior to analysis for metals. Cadmium, chromium, and zinc were detected in samples collected from the southwestern corner of the site during the first quarter of sampling at concentrations above the IT estimated ambient concentrations.

Twenty borings were drilled at the R Area Disposal Site during the SI. Fifty-two samples were collected from September 1989 to March 1990 at depths ranging from 0.2 to 10 feet bgs. Twenty-seven organic compounds were detected in the soil at the R Area Disposal Site, primarily VOCs and SVOCs. Eight VOCs, carbon tetrachloride, ethylbenzene, xylenes, 2-butanone, acetone, carbon disulfide, methylene chloride, and toluene, were detected at concentrations ranging from 1 to 2,800  $\mu\text{g/kg}$ . Four of these VOCs (methylene chloride, 2-butanone, and carbon tetrachloride) are

common laboratory contaminants, and carbon disulfide, occurs naturally in bay environments. The remaining VOCs were detected at concentrations ranging from 1 to 35  $\mu\text{g/kg}$  in soil from the central and southern portions of the site. Nineteen SVOCs were detected in the soil at sporadic locations and depths throughout the site. These SVOCs included 4-methylphenol, PAHs, benzoic acid, phthalates, and phenol at estimated concentrations ranging from 38 to 3,600  $\mu\text{g/kg}$ . One pesticide, 4,4'-dichlorodiphenyltrichloroethane (4,4'-DDT), was detected once in the northeastern area of the site at an estimated concentration of 17  $\mu\text{g/kg}$ . Four inorganics were detected at concentrations above the IT estimated ambient concentrations in the northern and central portions of the site.

In April 1990, 12 sediment samples were collected from six areas throughout the site. Five VOCs were detected in these samples; only total xylenes (an estimated 6  $\mu\text{g/kg}$ ) was neither a common laboratory contaminant nor a naturally occurring compound in bay environments. Thirteen SVOCs were detected in the sediment along the western border of the site. These SVOCs included 2,4,6-trichlorophenol, 2-nitroaniline, 4-bromophenyl phenyl ether, 4-chlorophenyl phenyl ether, benzoic acid, PAHs, phthalates, hexachlorobenzene, and n-nitrosodiphenylamine at concentrations ranging from 110 to 3,500  $\mu\text{g/kg}$ . The explosives compound 2,6-dinitrotoluene was detected in one sample along the western side of the site at an estimated concentration of 290  $\mu\text{g/kg}$ . Lead, mercury, and zinc were detected along the western site boundary at concentrations above the IT estimated ambient concentrations.

### **Resource Conservation and Recovery Act Facility Assessment**

The DTSC conducted a Resource Conservation and Recovery Act (RCRA) facility assessment (RFA) at NWS SBD Concord in July 1992. The purpose of the RFA was to identify and evaluate solid waste management units (SWMU) for historic and potential releases of hazardous waste to the environment. In addition, the RFA made preliminary determinations on the need for further corrective actions as part of the NWS SBD Concord hazardous waste operating permit (DTSC 1992).

Buildings R1, R2, R3, and R4 collectively known as the R Area buildings or the segregation facilities, are located on Froid Road along the southern boundary of the R Area Disposal Site. The segregation facilities sort and inspect conventional ammunition off-loaded from ships. Once inspected, the ammunition is designated for disposition and transferred to a magazine or holding yard (DTSC 1992). Exterior maintenance such as painting, stenciling, renovation, and packaging of the weapons is done at the segregation facilities. This routine maintenance generates waste paint cans and adhesives, which

may contain hazardous constituents stored in Building R-3. The R Area Buildings (R-1 through R-4) were designated SWMU 47 as part of the RFA. During the site visit, the only hazardous waste observed in the R Area was a drum of used aerosol paint cans (DTSC 1992).

### **Confirmation Sampling**

The purpose of the CS was to confirm the presence of chemicals detected during the SI and to evaluate the laboratory practical quantitation and detection limits that were achievable for soil and water samples. Samples collected during the CS conducted by PRC in 1993 consisted of one groundwater sample from well RADMW005 along the northern site boundary, one surface water sample from the southeastern corner of the site, and two sediment samples along the eastern site boundary. No VOCs, SVOCs, or OC pesticides and PCBs were detected in these samples. During the first quarter SI sampling, cadmium, chromium, and zinc were detected in the southwestern corner of the site at concentrations above the IT estimated ambient concentrations. During the CS, cadmium and chromium were not detected, and zinc was detected at a lower concentration than that reported in the SI.

### **2.7.3 Site 9: Froid and Taylor Roads**

The location of the Froid and Taylor Roads Site is shown on Figure 1-3. This section presents the history of operations at the Froid and Taylor Roads Site and the results of previous environmental investigations.

#### **2.7.3.1 Site Description and Operational History**

The Froid and Taylor Roads Site is a triangularly-shaped area, about 800 feet long and 300 feet wide. The site is bordered by Taylor Boulevard to the east, Froid Road to the north, and an unnamed dirt and asphalt road to the west. The Froid and Taylor Roads Site has changed significantly from 1939 to the present with the development of NWS SBD Concord. Aerial photographs taken in 1939 indicate little activity in the vicinity of the Froid and Taylor Roads Site (Figure 2-1). By 1950, the site was encompassed by Taylor and Froid Roads (Figure 2-2). One small road that cut through the Froid and Taylor Roads Site is apparent from 1950 aerial photographs and can still be observed on the site. The natural slough that once passed through the four sites of the Tidal Area was partially filled in the vicinity of the Froid and Taylor Roads Site to construct roads and buildings. A curved portion of the slough can still be seen (Figure 2-7), and a maximum tidal fluctuation of 2 inches was measured during the tidal influence study conducted in July 1994 (Section 5.2.1).

During the IAS, a piece of ordnance was found on the shoulder of Froid Road near its intersection with Taylor Boulevard. This piece of ordnance was later identified by explosive ordnance disposal personnel as a spent 5-inch white phosphorus rocket round. An investigation of the surrounding area revealed scrap metal and other debris in the area south of the intersection of the two roads. The IAS also noted that the site was subject to tidal action; however, it presented no information to justify this statement. Although no specific incidents of hazardous materials disposal were linked directly to this site, its proximity to Sites 1, 2, and 11 made it an area of concern during the IAS (E&E 1983).

#### **2.7.3.2 Results of Previous Investigations**

The following sections discuss the results of previous investigations at the Froid and Taylor Roads Site.

##### **Initial Assessment Study**

E&E conducted an IAS at the site in 1983. The IAS consisted of a historical records search, a visual inspection of the site, and interviews with NWS SBD Concord personnel. Based on the historical information, E&E recommended the site for further study (E&E 1983).

##### **Site Investigation**

IT conducted an SI at the Froid and Taylor Roads Site in 1992 and presented the results in the SI report for the Tidal Area (IT 1992). Based on the site history, IT determined the following to be risk drivers: VOCs, SVOCs, OC pesticides and PCBs, inorganics, and explosive compounds. Groundwater, surface water, soil, and sediment samples were collected from the Froid and Taylor Roads Site. The SI data qualifier problems described in Section 2.7.1.2 are also applicable to the Froid and Taylor Roads Site. The SI data is therefore of qualitative use only and is not used in the HHRA calculations (Section 7.0).

Five shallow monitoring wells (14 to 18 feet bgs) were installed around the perimeter of the Froid and Taylor Roads Site during the SI. Groundwater was sampled for four quarters (April-May, July-August, and October-November 1990, and January 1991). Four SVOC were detected in groundwater over the four quarters of sampling at estimated concentrations up to 21  $\mu\text{g/L}$ . Most of the detections occurred during the first sampling event, indicating that the wells may not have been properly developed or purged prior to sampling. Diphenylamine was detected during two sampling events at concentrations of 2.2 and 0.002  $\mu\text{g/L}$ . Five of the six inorganics were detected at concentrations above the IT

estimated ambient concentrations. The inorganic parameters measured by IT appeared to be elevated, probably reflecting brackish-saline groundwater (IT 1992).

Six surface water samples were collected from two sampling locations in April 1988, May 1989, and April 1990. Surface water samples were filtered with a 0.45 micron filter prior to analysis for metals. Zinc and arsenic were the only two inorganics detected in the surface water samples from the site; however, the concentrations were below the IT estimated ambient concentrations. IT noted elevated concentrations of inorganic analytes and attributed these concentrations to salts that may have accumulated from infrequent inundation of tidal water and on-site drying conditions.

Five soil borings were drilled and sampled at the site during September and November 1989. Seventeen soil samples were collected at depths ranging from 0.2 to 6 feet-bgs. Concentrations of tetrachloroethene (PCE) up to 3 µg/kg were detected in three soil samples collected from the northern part of the site. The SVOC pentachlorophenol (PCP) was detected at a concentration of 130 µg/kg in the 0.2-foot bgs soil sample collected from a boring located along the eastern edge of the site, adjacent to the Wood Hogger Site. PCP is a risk driver at the Wood Hogger Site. Several other SVOC were detected in soil samples from locations across the site, although nearly all concentrations were estimated (J-qualified). Chromium, copper, zinc, and selenium were detected in samples collected from boring FTS-3 at concentrations above IT estimated ambient concentrations.

Four sediment samples, ranging in depth from 0.2 to 1.0 foot bgs, were collected from two low-lying areas of the site. Phthalates were detected at two sampling locations at estimated concentrations up to 2,000 µg/kg. Cadmium, copper, and zinc were detected in samples collected along the western boundary of the Froid and Taylor Roads Site at concentrations above the IT estimated ambient concentrations.

### **Confirmation Sampling**

The purpose of the CS was to confirm the presence of chemicals detected during the SI and to evaluate the laboratory practical quantitation and detection limits that were achievable for soil and water samples. Two soil samples and two groundwater samples from wells FTSMW002 and FTSMW003 were collected during the CS conducted by PRC in 1993 to confirm the presence of PCE and SVOC (especially PCP in boring FTS-3). None of these chemicals were detected in the samples.

#### **2.7.4 Site 11: Wood Hogger Site**

The location of the Wood Hogger Site is shown on Figure 1-3. This section presents the history of operations at the Wood Hogger Site and the results of previous environmental investigations.

##### **2.7.4.1 Site Description and Operational History**

The Wood Hogger Site is bordered by Otter Sluice to the west and south, Froid Road to the north, and an unnamed dirt and asphalt road to the east. The site, as defined in the SI, has been expanded to include other areas contiguous to the immediate area of wood hogger operations. Historically, the Wood Hogger Site has been used as a dunnage and wood scrap area. In 1939, prior to Navy ownership, aerial photographs indicate little activity within the present Wood Hogger Site (Figure 2-1). A major slough trending from east to west channeled through the present areas of the R Area Disposal Site, Tidal Area Landfill Site, and Froid and Taylor Roads Site, and into the Wood Hogger Site. During construction of NWS SBD Concord the slough was backfilled, and Otter Sluice was constructed around the Wood Hogger Site and the R Area Disposal Site to channel water to Suisun Bay. By 1950, (with ongoing NWS SBD Concord development), the fill was extended across the Wood Hogger Site from the northeastern corner to the southwestern corner, forming the storage yard at the Wood Hogger Site (Figure 2-2). Aerial photographs were used to identify the extent of fill areas. Section 5.1.4 presents the geology across the site based on the RI soil borings.

From the early 1950s to the early 1970s, an incinerator was used to burn wood at the southwestern corner of the Wood Hogger Site. The incinerator is shown on 1952 and 1959 aerial photographs. The concrete foundation of the incinerator remains on the site. According to the aerial photographs from 1952 and 1959, a conveyor system was used to move scrap and dunnage material from the storage yard to the incinerator.

Between 1969 and 1973, dunnage and other wood scrap from Tidal Area operations were chipped using wood hogging equipment (IT 1992). Until about 1972, the chips were sold to the Fiberboard Company in Antioch, California (E&E 1983). When a market for the chips ended, the chips were deposited on the ground adjacent to the hogger. The chips were estimated to cover a 10-acre area at a thickness of up to 3.5 feet (IT 1992).

Some of the wood scraps chipped at the site came from Vietnam ordnance crates returned from Vietnam. Most ammunition shipping crates used by the Marines in Vietnam and some crates used by

the Army were treated with PCP, a wood preservative that has since been identified as a risk driver. The total amount of PCP-treated wood that may have been chipped and disposed of at the site was estimated at 20 tons (E&E 1983). Assuming the disposed wood chips had a density of 45 pounds per cubic foot, 20 tons of wood chips occupies a volume of approximately 20 cubic yards. The estimated total weight of PCP-treated wood disposal is based on the difference between the munitions shipped from and returned to NWS SBD Concord during the time that PCP-treated wood was used (E&E 1983). The Wood Hogger Site was identified in the IAS because of the on-site burial of wood chips, which were suspected to contain PCP. Wood chips were not expected to have been burned because the incinerator and hogger were not operated at the same time. Additionally, no ash was observed during characterization of the soil and wood chip fill.

Currently, the yard is used to store new wood products exclusively within the open-sided storage structure. The wood hogger machinery was used from 1969 to 1973 (shown on Figure 2-5); it is no longer in operation but remains on site. No treated or preserved wood is currently stored or handled at the site.

The site consists of a paved dunnage or materials storage yard aligned from southwest to northeast across the site, with unimproved open areas (that is, unpaved and with no constructed roads) north and south of the storage yard. A railroad spur is located at the northern edge of the storage yard. Aerial photographs from 1952 show this storage yard in use, with railroad tracks providing access to the storage yard from the northeastern corner of the site. Historical photographs and first-hand site observation indicated that a variety of wood and metal materials have been stored in sections of the yard at various times. The storage yard was identified as SWMU 37 during the RFA CS investigation in 1992 (Section 2.7.4.2). Locations adjacent to this SWMU were investigated as part of the RI to assess it as a potential source of site chemicals.

The open areas north and south of the storage yard consist of bare soil covered by intermittently sparse and dense vegetation. The bare soil areas just near the asphalt pavement contain some debris, the result of stored materials that were windblown or deposited in these areas.

The open area to the south is bordered by the former Scott Road, and Otter Sluice runs parallel to the southern side of the road. This open area was observed to drain to the south into a location north of the road; this location is apparently a permanent pond that is directly connected to Otter Sluice by a culvert. Observations during site visits suggest that the water level in the pond is about the same level

as that of Otter Sluice and may reflect groundwater levels. Small fish and birds were observed at ponds and channels in the southeastern corner of the open area.

The northern open area appears to drain toward the west to Otter Sluice. In April 1993, standing water was observed in the northern open area along the eastern side of the levee separating Otter Sluice from this area. A culvert connects the sluice and the standing water ponds; the presence of a water flow control mechanism, such as a culvert gate between the sluice and ponds, was not identified (Figure 2-7). Several large carp (about 18 inches long) were observed in these ponds during the April 1993 visit.

#### **2.7.4.2 Results of Previous Investigations**

The following sections discuss the results of previous investigations at the Wood Hogger Site.

##### **Initial Assessment Study**

E&E conducted an IAS at the site in 1983. The IAS consisted of a historical records search, a visual inspection of the site, and interviews with NWS SBD Concord personnel. Based on the historical information, E&E recommended the site for further study (E&E 1983).

##### **Site Investigation**

IT conducted an SI at the Wood Hogger Site in 1992 and presented the results in the SI report for the Tidal Area (IT 1992). Based on the history of the site, the following chemicals were determined to be chemicals of concerns: VOCs, SVOCs, OC pesticides and PCBs, inorganics, and explosive compounds. During the SI, groundwater, surface water, soil, and sediment samples were collected at the Wood Hogger Site. The 1992 SI report concluded that several groups of chemicals detected in the southern open area were linked to past site activities; however, the few samples collected in the northern open area were not sufficient to characterize this area, and no samples were collected in the storage yard itself. The SI data qualifier problems described in Section 2.7.1.2 are also applicable to the Wood Hogger Site. The SI data are therefore of qualitative use only and are not used in the HHRA calculations (Section 7.0).

During the SI, four shallow monitoring wells (13 to 18 feet bgs) were installed around and north of the wood hogger machinery. Groundwater was sampled for four quarters (April-May, July-August, and October-November 1990, and January 1991). During the four quarters of sampling, five SVOC were



detected in groundwater at concentrations up to 13  $\mu\text{g/L}$ . The SVOC 4-methylphenol was detected in two wells in the southwestern portion of the site during the second and third quarters of sampling at concentrations up to 13  $\mu\text{g/L}$ . Phthalates were detected during the first two quarters in samples collected from three wells located near the wood hogger machinery at estimated concentrations up to 6  $\mu\text{g/L}$ . During the first quarter of sampling, dibenzofuran was detected in a sample collected from a well near the southern portion of the site at an estimated concentration of 3  $\mu\text{g/L}$ . Six inorganics were detected; five of these were present at concentrations above the IT estimated ambient concentrations.

Twelve surface water samples were collected during April 1988, May 1989, and April 1990 from four locations along the southern and western site boundaries. No organic risk drivers were detected. Surface water samples were filtered with a 0.45 micron filter prior to metals analysis. No inorganics were detected at concentrations above the IT estimated ambient concentrations.

Fifteen soil borings were drilled during the SI, and 40 soil samples were collected in September 1989, November 1989, and March 1990. Sample depths ranged from 0.2 to 2.0 feet bgs, and one sample was collected at 9.0 feet bgs. A total of 31 organic compounds was detected in the soil at the Wood Hogger Site. The VOC PCE was detected twice at estimated concentrations ranging from 2 to 8  $\mu\text{g/kg}$  in samples collected from the one boring drilled in the northern portion of the site. Twenty-three SVOCs were detected in the soil in the southern and southwestern portions of the site. These SVOCs included 2-methylnaphthalene, 3,3'-dichlorobenzidine, benzoic acid, PAHs, and phthalates, which were detected at estimated concentrations ranging from 48 to 14,000  $\mu\text{g/kg}$ . PAHs accounted for 16 of the SVOCs detected. The risk driver PCP was detected at an estimated value of 1,000  $\mu\text{g/kg}$  in one sample collected from 0.2 feet bgs in the southern open area adjacent to the wood hogger machinery. The PCP may be associated with PCP-treated wood, and the PAHs may be associated with creosote-treated wood or incinerator ash. Some of the highest SVOC concentrations were found in the 9.0-foot-bgs sample; however, no direct correlation between depth and concentration was evident. The pesticides DDT and chlordane were detected four times in soil samples at estimated concentrations up to 620  $\mu\text{g/kg}$ . These pesticides may be present at the Wood Hogger Site as a result of past mosquito abatement efforts or disposal of pesticide-treated wood returned from overseas. Three explosive compounds were detected in two borings. Nitrobenzene and 2,6-dinitrotoluene were detected in soil collected from WHS-10 at 2.0 feet bgs at estimated concentrations of 1.0 and 0.16  $\mu\text{g/kg}$ , respectively. Diphenylamine was detected at a concentration of 0.13  $\mu\text{g/kg}$  in soil collected from WHS-4 at 2.0 feet bgs. Four of the six inorganics were detected at concentrations above the IT estimated ambient

concentrations. Several samples contained copper at anomalously high concentrations above 3,000  $\mu\text{g/kg}$ , as compared to site-wide mean concentrations of 100 to 200  $\mu\text{g/kg}$ . These results may indicate the presence of copper-based wood treatment chemicals.

In April 1990, eight sediment samples were collected from four areas throughout the site. Two SVOC, both of which were phthalates, were detected at all sampling locations at estimated concentrations ranging from 110 to 960  $\mu\text{g/kg}$ . Copper and zinc were detected along the southern portion of the site at concentrations above the IT estimated ambient concentrations.

### **Resource Conservation and Recovery Act Facility Assessment**

An RFA performed by DTSC in 1992 cited Building A-29 in the "Dunnage Salvage Yard" as SWMU 37. The particular concerns cited in the RFA were wood treated with creosote, PCP, and copper arsenate. Although not specifically stated, the likely environmental concern was from chemicals in scrap, sawdust, and runoff from the stored wood, rather than the wood itself. The discussion of SWMU 37 in the 1995 RFA confirmation study does not mention concerns for releases from the scrap metal piles in the storage yard; however, this material may serve as a source of chemicals found in the open areas. Results from a further RFA investigation at SWMU 37 have been incorporated into the RI and are presented in Section 5.4.4.

### **Confirmation Sampling**

The purpose of the CS was to confirm the presence of chemicals detected during the SI and to evaluate the laboratory practical quantitation and detection limits that were achievable for soil and water samples. Two groundwater samples (WHSMW003 and WHSMW004) and three soil samples were collected at the Wood Hogger Site during the CS. Butanone, acetone, and phthalates were reported previously in the SI; however, they were not detected in the groundwater samples. These chemicals are believed to be sampling or laboratory artifacts but were included in further sampling efforts to confirm their absence. Soil samples collected during the CS conducted by PRC in January 1993 contained PAHs at estimated concentrations up to 520  $\mu\text{g/kg}$  and the pesticides chlordane (an estimated 13.2  $\mu\text{g/kg}$ ), 4,4'-DDT (3.16  $\mu\text{g/kg}$ ), 4,4'-dichlorodiphenyldichloroethane (4,4'-DDD) (59.9  $\mu\text{g/kg}$ ), and dieldrin (3.3  $\mu\text{g/kg}$ ).

### **3.0 INVESTIGATION METHODS**

The NWS SBD Concord Tidal Area RI field methods consisted of site reconnaissance activities; sediment, soil, surface water, and groundwater investigations; and a tidal influence survey. This section discusses the field methods and field QA/QC procedures, the analytical program, and data validation procedures. Deviations from the investigation approach outlined in the FSP are also discussed in this section. Additional information on field methods, field QA/QC, the analytical program, and data validation are contained in the Tidal Area RI WP and FSP.

#### **3.1 RECONNAISSANCE ACTIVITIES**

Reconnaissance activities were conducted in 1995 prior to sampling activities at the Tidal Area sites. Initial reconnaissance activities consisted of a biological and an ecological site clearance. The reconnaissance activities were conducted before the field investigation to identify potential impacts to sensitive, threatened, or endangered species habitats.

The Tidal Area was assessed to determine if any wildlife species, nesting sites, or sensitive habitats were present and to assess ways to identify or minimize the impact to these areas from investigation activities. After assessing the sites, it was decided that field personnel would stay on grid-line paths while traversing the sites to minimize impact to the total area by foot traffic. Field activities were also conducted in a way that minimized potential impacts to flora and fauna, such as collecting samples by hand-operated tools without the use of motorized auger rigs or off-road vehicle support. All field activities were coordinated with regulatory agencies, including the EPA, RWQCB, USFWS, and the CDFG.

#### **3.2 SOIL INVESTIGATION**

The Tidal Area Site soil investigation was conducted during the summer of 1995 and involved the collection of 303 soil samples from the four sites and SWMU 37. Of these samples, 200 samples were collected from surface soils (0 to 0.5 feet bgs), and 103 samples were collected from subsurface soils (greater than 0.5 feet bgs). The maximum depths that soil samples were collected at each site were 5.8 feet bgs at Site 1, 5.8 feet bgs at Site 2, 2.5 feet bgs at Site 9, and 20 feet bgs at Site 11. The number of surface and subsurface soil samples collected at each site are summarized in Table 3-1. Soil sampling locations are shown in Exhibit 1.

The majority of soil samples were collected from the surface because overland flow of dissolved or particulate-sorbed chemicals was anticipated to be the dominant transport process of concern at the Tidal Area sites. Subsurface transport of contaminants was determined to be a less significant means of contaminant transport based on the results of previous investigations, which indicated that the sites were underlain by Bay Mud with very low permeabilities. The surface soil sampling data were analyzed in order to evaluate the potential transport and distribution of risk drivers via the erosion and redeposition of potentially contaminated soils and sediments by surface water at the sites.

Soil sample locations were based upon a grid pattern at two of the four sites to uniformly cover these sites with an unbiased or systematic sampling pattern. Sample locations were also selected at locations where contamination was judged to be likely. Sample locations based upon judgement are biased to assure sample coverage in areas of potential human health or ecological risk. Biased samples were collected from areas of known or suspected disposal. The biased sampling provided specific information for assessing whether contamination had occurred from the landfill or from other areas where disposal was suspected based on site observations. In addition, "buddy" samples were collected about 10 feet away from randomly selected grid samples. The additional samples were collected to assess spatial variations in concentrations on a smaller scale than the grid spacing.

Nearly all surface and subsurface soil samples were collected by non-mechanical methods, using either hand-pushing or hammer-driving to advance a 2-inch-diameter, stainless-steel, core barrel sampler to the desired soil boring depths. Clear acetate sleeves, which were inserted into the stainless-steel core barrel, served to contain the soil samples for visual logging of the soils and laboratory submittal, thus minimizing disturbance of the sample. A truck-mounted hydraulic push-probe was used at five locations at the Wood Hogger Site to assist with the soil sampling. For these locations, a 2-inch-diameter core barrel with acetate sleeves was attached to the hydraulic push-probe, which allowed the collection of soil samples at depths up to 13 feet bgs.

Each soil sample boring was logged using the Unified Soil Classification System (USCS) (American Society of Testing and Materials [ASTM] D2488). In addition, the vegetation and general geomorphic features were recorded, and a photograph was taken at each soil sampling location. All soil boreholes were field-screened for organic vapors using a photoionization detector (PID). For PID screening, glass jars were partially filled with small quantities of soil, sealed, and shaken vigorously. After about 5 minutes, the PID probe was inserted into the jar headspace and the reading was recorded. Each

distinct soil type from each borehole was analyzed. The site conditions, boring logs, and PID readings were used qualitatively to determine the need for contingency samples.

Biased and unbiased (systematic grid) soil samples were analyzed for SVOCs, OC pesticides and PCBs, inorganics, pH, and TOC. Buddy samples were analyzed for metals and pH. In addition, selected samples were analyzed for the following chemical constituents: VOCs, extractable total petroleum hydrocarbons (TPH-e), explosive compounds, inorganics (including hexavalent chromium), sulfides, and dioxins and furans. Selected samples were also analyzed for the following physical characteristics: grain size, moisture content, dry density, specific gravity, and permeability. Soil sample analytical results are presented in Appendices A through D. The rationale for the analysis of the chemical and physical characteristics of samples is presented in the RI WP.

The soil boreholes in the R Area Disposal and the Froid and Taylor Road Sites were backfilled with the native drill cuttings. In the Tidal Area Landfill and Wood Hogger Sites the soil boreholes were backfilled with clean, imported soil. Imported soil was used as backfill at the Tidal Area Landfill and Wood Hogger Sites because the material removed during sampling contained debris and wood chips, which may have prevented the boreholes from being thoroughly backfilled.

### **3.3 SURFACE WATER INVESTIGATION**

Surface water samples were collected at Otter Sluice and within the R Area Disposal, Froid and Taylor Roads, and Wood Hogger Sites during four quarterly sampling periods: July 1995, October 1995, January 1996, and April 1996. An additional round of surface water sampling was conducted in June 1998 at the Froid and Taylor Roads Site. Surface water sample locations are shown in Exhibit 2. Surface water is not present at the Tidal Area Landfill. Surface water elevations were also recorded and used in conjunction with measurements of groundwater elevations to produce water level maps for each sampling period.

Surface water samples were collected from the sloughs and drainage ditches by submerging the sample containers then adding the necessary preservative following sample collection. All efforts were made to minimize the amount of sediment collected with the samples. The surface water samples were not filtered. Surface water samples were collected at 17 locations at the R Area Disposal Site, 5 locations at the Froid and Taylor Roads Site, and 6 locations at the Wood Hogger Site. Most surface water samples were analyzed for VOCs, SVOCs, OC pesticides and PCBs, explosive compounds, inorganics,

TOC, total suspended solids (TSS), pH, and conductivity. In addition, the two samples collected at the Froid and Taylor Road Site were analyzed for TPH-e. Surface water sample analytical results are presented in Appendices B through D.

### **3.4 GROUNDWATER INVESTIGATION**

Depths to groundwater were measured in the 23 existing monitoring wells located throughout the four sites. Groundwater well locations are shown in Exhibit 2. All monitoring wells had been previously installed by IT during the site investigation. As part of the RI, two additional shallow piezometers, RADPZ001 and RADPZ002, were installed by direct-push methods in the north-central portion of the R Area Disposal Site. The piezometers were used to measure the groundwater levels in an area with incomplete spatial coverage by monitoring wells. No RI groundwater samples were collected because representative groundwater samples could not be collected from the wells that were screened in Bay Mud.

In September 1994, a low-flow purging and sampling procedure was explored for use at four wells in the Tidal Area of NWS SBD Concord. The 23 Tidal Area monitoring wells were sampled again from October 6 to October 15, 1997. Where possible, groundwater samples were collected using low flow-rate purging techniques. In many cases, the recharge rate in the wells would not support low flow-rate sampling, and the wells were sampled using a natural settling technique to reduce sample turbidity. Both well sampling techniques are discussed in the "Confirmation Groundwater Sampling Technical Memorandum" (TtEMI 1998b).

In 14 of the 23 wells sampled, rates of groundwater recharge to the wells from the formation were lower than the lowest pumping rates (less than 0.1 liter/minute). Samples collected from these wells using low flow-rate techniques would have consisted predominantly of stagnant water from the well casing rather than water from the water-bearing formation. Therefore, these 14 wells were sampled using a natural settling technique rather than a low flow-rate technique. Groundwater elevations measured during the four monitoring well gauging events (July 1995, October 1995, January 1996, and April 1996) were used in conjunction with surface water elevations to produce area-wide water level maps for each gauging event. Groundwater elevation maps are presented as Figures 5-7 through 5-12. Groundwater elevations were measured again in 1998 during the confirmation groundwater sampling conducted for the Tidal Area. The most recent groundwater potentiometric surface maps are presented

on Figures 11 through 15 of the "Confirmation Groundwater Sampling Technical Memorandum" (TtEMI 1998b).

### **3.5 QUALITY ASSURANCE/QUALITY CONTROL FIELD PROCEDURES**

Field QA/QC samples were collected for laboratory analysis to check sampling and analytical precision, accuracy, and representativeness. The analytical results for the QA/QC samples are discussed in the QC summary report (QCSR) presented in Appendix K. The QA/QC samples were consistent with guidelines presented in the Navy QA/QC requirements (Naval Energy and Environmental Support Activity [NEESA] 1988). In addition, the QA/QC program presented in this section meets appropriate regulatory guidance (EPA 1990a).

#### **3.5.1 Field Duplicate Samples**

Field duplicate samples were collected at the same time and from the same sampling matrix as the original samples and were submitted to the laboratory as separate samples to assess the consistency of the overall sampling and analytical system. Field duplicates were collected for 10 percent of all samples and were analyzed for the same constituents as the original sample. The 10 percent basis was determined separately for each sample matrix and did not include the QC samples. The field duplicates were collected, numbered, packaged, and sealed in the same manner as other samples and were submitted blind to the laboratory.

#### **3.5.2 Laboratory Split Samples**

Laboratory split samples were collected from three locations in the R Area Disposal Site and were analyzed for SVOCs, OC pesticides and PCBs (using low detection limits). In addition, laboratory split samples were collected for rinsate water samples (collected about every 2 days).

#### **3.5.3 Referee Samples**

Referee duplicate samples were collected to evaluate interlaboratory analytical precision and accuracy as well as to serve as external QA samples. These samples were collected and sent to a referee QA laboratory only when regulatory agencies collected split samples. The collection method for referee duplicates or referee split samples was identical to the collection method used for field duplicate samples, as described previously.

#### **3.5.4 Source Water Blank**

One source water blank sample was collected from the base domestic water source to determine quality parameters. The source water sample was analyzed for the same parameters as the samples collected during the Phase IA RI. The source water was used throughout the investigation as detergent wash water for decontamination procedures.

#### **3.5.5 Equipment Rinsates**

Equipment rinsates are used to evaluate the effectiveness of sampling equipment decontamination. The equipment rinsates were collected after a sample collection device, such as a split-spoon sampler or bailer, was decontaminated using standard procedures. Appropriate water for the intended analysis was poured over or through the sampling device, collected in a sample container, and sent as a blind sample to the laboratory for analysis. High performance liquid chromatography water or equivalent organic-free water was used in the organic analyses, and deionized water was used for inorganic analyses. Equipment rinsate samples were collected daily.

#### **3.5.6 Trip Blanks**

Trip blanks are used to identify possible sample contamination originating from sample transport, shipping, or site conditions. Trip blanks were prepared in the laboratory using organic-free water. Next, they were shipped with the sample containers to the field, stored with the field samples, and returned to the laboratory with the samples scheduled to be analyzed for VOCs. One trip blank accompanied each cooler containing VOC samples. Analysis for VOCs was performed because these compounds have the greatest potential for cross-contamination.

#### **3.5.7 Quality Control Practices**

Field measurements were recorded while water samples were collected. These measurements and the associated QC practices are as follows:

- pH, specific conductance, turbidity, and temperature were measured in duplicate at a frequency of 10 percent
- Water levels were measured in duplicate at a frequency of 10 percent



Subcontractors conducting field activities followed QC practices as provided in their standard operating procedures (SOP). Results from field measurements and QC checks were compared to the precision, accuracy, representativeness, completeness, and comparability (PARCC) criteria presented in Section 3.0 of the QAPP.

### **3.6 TIDAL SURVEY**

Tidal fluctuations in oceans and hydraulically connected surface water bodies (such as bays, tidal marshes, or streams) sometimes produce groundwater level fluctuations in adjacent, hydraulically connected coastal aquifers. These tidal effects may cause fluctuations in groundwater gradients and flow directions, ultimately affecting contaminant migration. The tidal influence survey at NWS SBD Concord was conducted to assess whether significant tidal influence on groundwater levels occurs at the site. The goal of the survey was to quantify the degree of influence from seasonal and daily tidal fluctuations on surface water and groundwater levels.

The tidal influence survey was conducted using eight groundwater monitoring wells to evaluate the potential for hydraulic influence, including time lapse effects, between tidal changes in Suisun Bay and surface water and groundwater level fluctuations at NWS SBD Concord. Data loggers were installed in groundwater monitoring wells, at surface water monitoring locations, and in Suisun Bay.

The tidal influence survey was conducted by continuously measuring the change in static water levels in eight groundwater monitoring wells and nine surface water monitoring sites, including five locations in Otter Sluice, one location in Suisun Bay at the outfall of Otter Sluice, and three locations within site boundaries (Figure 3-1). The monitoring locations and duration are presented in Table 3-2. Field data were continually recorded using In-Situ Hermit 2-channel SE 1000C or 6-channel SE 2000 data loggers and pressure transducers. Before the data loggers were installed, static water levels were recorded for each monitoring well. The pressure transducers were then installed in each well, and the data loggers were programmed to record water levels every 15 minutes during the tidal survey. When the monitoring period was complete, the data recorded on the data logger were downloaded onto a computer and plotted by graphing the net change in water level versus time. Results of the tidal survey are presented in Section 5.2.

### **3.7 DEVIATIONS FROM PROPOSED INVESTIGATION APPROACH**

The following deviations from the proposed investigation approach occurred during the sampling and analysis for the four Tidal Area sites.

#### **3.7.1 Tidal Area Landfill Site**

One additional soil boring, TL-SB-08, was drilled at the request of the EPA representative on site.

#### **3.7.2 R Area Disposal Site**

One surface soil grid location, RAD-SD-A8, was moved because of access problems. Surface water samples proposed at three locations were not collected during the first round of sampling because of a lack of surface water. Three field contingency soil samples were collected at the R Area Disposal Site based on observed site conditions at the time of sampling.

#### **3.7.3 Wood Hogger Site**

Soil samples were not collected as proposed from grid locations L3, K2, and J3 because two of these grid locations were on the railroad tracks and one was on the road. Grid locations E8, G6, E6, and C6 were sampled in alternate locations because of access problems: E8 was located in a slough, G6 and E6 were inside a fenced area, and C6 was located inside a wood-constructed warehouse. One contingency soil sample was collected at the Wood Hogger Site.

### **3.8 ANALYTICAL PROGRAM**

The analytical program for the NWS SBD Concord Tidal Area sites was designed to provide users with data of known quality. To achieve this goal, documented procedures were followed for the identification and documentation of all samples collected, containerization and preservation of all samples, sample custody and shipment control, internal QC checks for field and laboratory analyses, data reduction and reporting, and data validation. Each of these procedures is described in the following sections.

#### **3.8.1 Identification and Documentation of Samples**

Immediately following sample collection, a sample number was assigned, the sample container was labeled, and the sample collection was documented. The sample numbering scheme was compatible

with both the Navy and laboratory computerized database management systems. The numbering scheme allowed each sample to be uniquely identified and provided a means of tracking the sample from collection through analysis. The sample numbers identify the site, sample matrix (for example, sediment, soil, or surface water), and location of the sample. This numbering scheme is consistent with those used for all NWS SBD Concord sampling efforts.

The numbering scheme does not provide the laboratory with any information that could bias the reported results, which is especially important for field QC samples. The procedures for numbering the field QC samples (field duplicates, equipment blanks, and trip blanks) are described in Section 3.8.1.2. The other QC samples collected for this project were the matrix spike and matrix spike duplicate (MS/MSD) samples. The MS/MSD samples are required by the laboratory to measure precision and accuracy of the analytical methods. The MS/MSDs, however, are not considered unique samples, and the extra sample volumes were numbered with the sample number of the original sample.

Once the sample number was determined, it was recorded on sample labels, field tracking sheets, chain-of-custody forms, and other records documenting sampling activities such as the field logbook.

#### **3.8.1.1 RI Location Identification System**

The RI location identification system consisted of three parts: (1) the RI site, (2) the location type (for example, soil boring or surface water), and (3) the specific location (for example, biased and unbiased [systematic grid sample] location). Examples of the location identification system and each of its four parts follow:

<u>RI Site Abbreviation</u>	<u>Location Type Abbreviation</u>	<u>Specific Location</u>
TLS (Tidal Landfill Site)	SB (soil boring)	001
RAD (R Area Disposal Site)	SB (soil boring)	B04
WHS (Wood Hogger Site)	ST (sediment)	003
FTS (Froid and Taylor Roads Site)	SW (surface water)	002

The RI site abbreviation is a three-letter code identifying the RI site. The location type abbreviation is a two-letter code for the type of location. The specific location is a three-character code or three-digit number used to identify specific unbiased (systematic grid) or biased sampling locations. For example,

grid node A01 would be located at the intersection of column A and row 01. Biased sample locations were identified consecutively. Samples collected at different times from the same location (for example, surface water) were differentiated by the date of collection and the sample identification number.

All locations were recorded on appropriate forms during field activities to identify the location corresponding to the sample sent to the laboratory.

### **3.8.1.2 RI Sample Identification System**

The sample identification system was developed in order to submit blind samples to the laboratory, that is, sample identification names that did not contain information about the purpose of the sample. The sample identification consisted of four parts (1) the CTO number, (2) the RI site from which the sample was collected, (3) the sample type, and (4) the sample number. Examples of the sample identification system and each of its four parts follow:

<u>CTO Number</u>	<u>RI Site Abbreviation</u>	<u>Sample Type Abbreviation</u>	<u>Sample Number</u>
281	TLS (Tidal Area Landfill)	SS (soil)	001
281	RAD (R Area Disposal Site)	SS (soil)	002
281	WHS (Wood Hogger Site)	ST (sediment)	003
281	FTS (Froid and Taylor Roads Site)	SW (surface water)	004

The RI site abbreviation remains the same for both the location and sample identification system. The sample type abbreviation is a two-letter code for the type of sample collected. The sample number is a three-digit sequential code for each type of sample at each site. For each sample type (soil, sediment, and surface water) samples were numbered sequentially.

Field QC samples (trip blanks, duplicates and equipment blanks) were numbered sequentially to ensure that all samples were submitted blind to the laboratory. For example, a trip blank sent to the laboratory with surface water samples collected from Site 11, the Wood Hogger, was identified as 281WHSSW020 (the last sample collected that day would have been 281WHSSW019). Surface water samples analyzed for MS/MSD were noted in the remarks section on the chain-of-custody forms.

### **3.8.2 Sample Analysis, Containerization, and Preservation**

Samples were placed in containers appropriate for the intended analyses and a preservative was added, as necessary. All soil and water analyses were conducted at an off-site analytical laboratory. Analytical methods, sample containers, holding times, and preservative requirements are listed in Tables 3-3 (soil and sediment) and 3-4 (surface water).

## **3.9 DATA VALIDATION**

Data validation is a systematic process for reviewing and qualifying data against a set of criteria to assure that the data are adequate for their intended use. This is accomplished by reviewing and evaluating all analytical data against PARCC criteria. The laboratory analytical data generated during the NWS SBD Concord RI were validated in accordance with EPA procedures (EPA 1994b, 1994c), and procedures in the QAPP for NWS SBD Concord (PRC 1995). The results of data validation are discussed in the QCSR presented in Appendix K.

The scope of the data validation encompassed results for 15 soil samples, 19 sediment samples, 12 RI surface water samples, and 22 tissue samples. The analytical program included the following analyses: contract laboratory program (CLP) SVOCs, CLP pesticides and PCBs, low detection limit OC pesticides and PCBs, CLP metals, dioxins, moisture content, and TOC. The analytical methods and references are listed in Table 3-5 for surface water samples and Table 3-6 for soil, sediment, and tissue samples.

### **3.9.1 Validation and Verification Methods**

Validation and verification of the data generated during field activities are essential to ensuring that the data is defensible and of acceptable quality. Data values that are significantly different from the population are called "outliers." Outliers may represent actual sample concentrations or may result from improper sampling or analytical methodologies, matrix interferences, data transcription errors, and calculation errors. Outliers resulting from errors found during data verification were identified and corrected; those that could not be attributed to analytical, calculation, or transcription errors were reported in the case narrative section of the analytical report. Additional verification methods for field and laboratory activities are presented in the following two sections.

#### **3.9.1.1 Field Data Verification**

Field personnel reviewed field data to identify inconsistencies or anomalous values. Any inconsistencies discovered were resolved immediately, if possible, by seeking clarification from the personnel responsible for data collection. All field personnel were responsible for following the sampling and documentation procedures described in the FSP to ensure that defensible and justifiable data were obtained.

#### **3.9.1.2 Laboratory Verification of Data**

Laboratory personnel assessed the data at the time of analysis and reported, through a review of raw data, any nonconformances in analytical method protocols. Detailed procedures for laboratory validation and corrective action are described in the laboratory QA plan. The laboratory QA plan discusses sample control, methods of analyses, calibration procedures, document control, QC, corrective actions, QC checks, QA, and data review.

#### **3.9.1.3 Analytical Data Validation**

Data validation is a systematic process of reviewing and qualifying data against a set of criteria to ensure that the data are adequate for their intended use. During the validation process, all results were identified as either acceptable for use, estimated and acceptable for limited use, or rejected and unacceptable for use. Results that were rejected were retained in the database but were not used in quantitative evaluations. Estimated and rejected data can result from improper sampling or analytical methodologies, matrix interferences, errors in data transcription, and changes in instrument performance. Erroneous results found during field and laboratory data validation were identified and corrected.

The validation procedure for non-CLP methods involved (1) reviewing the requirements of the analytical method and the project QAPP, (2) reviewing the data package to ensure that the requirements of the analytical methods and the QAPP were met, and (3) reviewing the data package against applicable criteria per the EPA functional guidelines. Although the functional guidelines do not specifically address analyses other than CLP methods, the general concepts presented in the guidelines were applied to the non-CLP analytical methods.

### **Cursory Data Validation**

Cursory validation was performed on the data summary packages for analyses of soil and surface water samples by CLP and non-CLP methods. All data were validated and qualified using the established criteria. Data summary packages consist of sample results and QA/QC summaries (equivalent to CLP forms I through X for organic analyses and forms I through XIV for inorganic analyses), including calibration and internal standard data. The number of samples in a sample delivery group (SDG) did not exceed 20.

### **Full Data Validation**

Full validation was performed on data packages for analyses of soil and surface water samples by CLP and non-CLP methods. All data were validated and qualified using the established criteria. Full validation was performed on about 10 percent of the sample data group. Data packages consisted of sample results, QA/QC summaries (equivalent to CLP forms I through X for organic analyses and forms I through XIV for inorganic analyses), and all raw data associated with the sample results.

#### **3.9.2 Data Validation Criteria**

The QC criteria reviewed for both cursory and full validations are as follows:

- CLP organic analyses: holding times, calibration, gas chromatograph tuning, internal standard performance, blanks, surrogate recovery, target compound list (TCL) identification, compound quantitation and reported detection limits, tentatively identified compounds (TIC), MS/MSD recovery, blank spike or laboratory control sample recovery, overall assessment of data for an SDG, and field duplicate sample analysis.
- CLP inorganic analyses: holding times, calibration, blanks, interference check sample (ICS), laboratory control sample, sample result verification, MS/MSD sample analysis, field duplicate sample analysis, inductively coupled plasma (ICP) serial dilution, graphite furnace atomic absorption, QC, and overall assessment of data for an SDG.

The Tidal Area project chemist reviewed the data validation reports from the validation subcontractor to assess whether DQOs were met and to determine whether the data are usable for their intended purpose.





## **4.0 LAWS AND REGULATIONS**

The following sections identify the preliminary ARAR for the NWS SBD Concord Tidal Area. ARARs are substantive federal and state environmental laws and regulations that provide cleanup levels or performance standards for the remedial alternatives to be developed for the Tidal Area sites. The ARAR identification process begins during the planning stages of the RI and continues as alternatives are developed and evaluated in the FS. ARARs are finalized in the remedial action decision document. ARAR definitions are discussed in Section 4.1. Section 4.2 through 4.5 evaluate environmental requirements and identify preliminary ARARs for the Tidal Area sites.

Planning for the Tidal Area Landfill site has progressed through the FS stage and is now in the ROD stage. A draft ROD dated September 28, 1998, is complete, and the ROD will be finalized in 1999 after a public meeting and comment period are held.

### **4.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS DEFINITIONS**

Section 121(d) of CERCLA, as amended by SARA, states that on-site remedial actions must attain ARARs. ARARs may include regulations, standards, criteria, or limitations promulgated under federal or state laws. An ARAR may be either "applicable" or "relevant and appropriate," but not both. The NCP (40 Code of Federal Regulations [CFR] Part 300) defines "applicable," "relevant and appropriate," and "to be considered" as follows:

- "Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable."
- "Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under federal or state environmental or facility siting law that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate."

- “Advisories, criteria, guidance, or proposed standards to be considered (TBC) consist of advisories, criteria, or guidance that are developed by EPA, other federal agencies, or states that may be useful in developing CERCLA remedies. The TBC values and guidelines may be used as EPA deems appropriate.”

The identification of ARARs involves a number of site-specific factors including potential remedial actions, chemicals of concern at the site, physical characteristics of the site, and site location. A requirement is applicable if it directly and fully addresses or regulates the hazardous substance, pollutant, contaminant, action being taken, or other circumstances at the site. To determine whether a particular requirement would be legally applicable, it is necessary to evaluate specific jurisdictional prerequisites of the statute or regulation. All pertinent jurisdictional prerequisites must be met for the requirement to be applicable. Jurisdictional prerequisites include:

- Who, as specified by the regulation, is subject to its authority;
- The types of substances and activities listed as falling under the authority of the regulation;
- The time period for which the regulation is in effect; and
- The types of activities the regulation requires, limits, or prohibits.

If jurisdictional requirements are met, the requirement is applicable. If not, the next step is to consider whether the requirement is relevant and appropriate (EPA 1988).

The basic considerations in determining whether a requirement is relevant and appropriate include evaluating whether the requirement (1) regulates or addresses problems sufficiently similar to those encountered at the CERCLA site (that is, relevance), and (2) is well suited for use at the particular site (that is, appropriateness). Determining whether a requirement is relevant and appropriate is site specific and must be based on best professional judgment (EPA 1988). A requirement may be relevant but not appropriate for the specific site. However, cleanup must comply with only those requirements that are determined to be both relevant and appropriate. Portions of a requirement may be relevant and appropriate even if the entire requirement is not (EPA 1988).

Waivers from attaining specific ARARs may be obtained under certain conditions, as presented in Section 121(d)(4) of CERCLA as amended by SARA. These conditions are as follows:

- The remedial action selected is only part of a total remedial action that will attain the ARAR when completed.

- Compliance with the ARAR will result in greater risk to human health and the environment.
- Compliance with the ARAR is technically impractical from an engineering perspective.
- The remedial action selected will attain a standard of performance equivalent to the ARAR through use of another method or approach.
- With respect to a state ARAR, the state has not consistently applied or demonstrated the intention to consistently apply the standard, requirement, criteria, or limitation in similar circumstances for other remedial actions within the state.

Several of these waivers may be relevant to the Tidal Area sites as a whole or to specific remedial alternatives and will require further technical evaluation. As the RI/FS and design phases progress, the applicability of these waivers will be assessed. The Navy may apply for a waiver if deemed applicable provided that the remedial actions are protective of human health and the environment.

The Navy has formally requested state ARARs for all NWS SBD Concord Tidal Area sites (WESTDIV 1993). Responses were received from the following state agencies:

- RWQCB
- DTSC
- CDFG
- San Francisco Bay Conservation and Development Commission (BCDC)

The information received from state agencies was not site specific and contained only generic references to state requirements. The Navy has met with state regulators informally to discuss ARARs specific to the Tidal Area sites. Based on these meetings, the Navy has attempted to describe how state requirements apply to Tidal Area sites.

Three categories of ARARs exist: chemical-, location-, and action-specific requirements. Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical cleanup values. These values specify the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. If more than one ARAR applies to a chemical, the most stringent will be identified as an ARAR for any remedial action. Four media are associated with the Tidal Area sites that may have been assigned chemical-specific ARARs: soil, ambient air (as affected

by landfill gas), surface water, and sediment. Groundwater was sampled as part of the remedial investigation but is not considered a medium of concern (TrEMI 1998b).

Location-specific ARARs are restrictions on the concentration of hazardous substances or the conduct of activities due to the characteristics of the site or its immediate environment. For example, site location or proposed remedial action in a flood plain, wetland, historic place, or sensitive ecosystem may trigger location-specific ARARs.

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken. These requirements are triggered by the particular remedial activities selected. Action-specific ARARs do not in themselves determine the remedial alternative; rather, they indicate how an alternative must be conducted. Action-specific ARARs are identified for Site 1 (Tidal Area Landfill only), based on the assumption that the presumptive remedy for landfills (containment) will be the remedy for the site. Action-specific ARARs for the other three Tidal Area sites will be identified only if an FS is conducted for these sites.

TBCs may be used when ARARs do not exist for a certain contaminant or medium. TBCs may include remediation goals calculated using EPA's "Risk Assessment Guidance for Superfund" Part B or other guidance and criteria available from other federal and state agencies. Cleanup levels for soil and sediment must be established using TBCs because no ARARs exist for soil contaminants. Section 6.0 discusses the screening criteria used to evaluate data collected during the RI. These screening criteria are TBCs and may or may not become cleanup levels for soil or sediment.

Sections 4.2 through 4.5 below describe the environmental requirements that may be pertinent to the Tidal Area sites and the preliminary ARARs identified for each site. The ARARs preliminarily identified in this RI report may change as the RI/FS and remedy selection processes for the Tidal Area sites proceed. Such changes may include (1) screening out requirements identified as preliminary ARARs, or (2) identifying additional requirements as ARARs.

#### **4.2 PRELIMINARY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TBCs FOR SITE 1 - TIDAL AREA LANDFILL**

The subsections below evaluate and identify preliminary location- and action-specific environmental ARARs and TBCs that may be pertinent to the Tidal Area Landfill.

#### **4.2.1            Location-Specific Applicable or Relevant and Appropriate Requirements for Site 1 – Tidal Area Landfill**

The location-specific ARARs for the Tidal Area Landfill are associated with the potential presence of endangered or threatened species and with the site being located in the coastal zone. Remedial actions taken at the landfill must be designed to conserve any endangered species. Table 4-1 lists the location-specific ARARs for the Tidal Area Landfill.

#### **Threatened and Endangered Species and Wildlife Protection Statutes**

Substantive requirements of the federal Endangered Species Act of 1973 (16 USC 1531, et seq.) and the California Fish and Game Code (FGC) (FGC Sections 2080, 3511, 3513, and 5650) were included as ARARs because threatened and endangered species, migratory nongame birds, and mammals do occur in the Tidal Area. No endangered, threatened, or otherwise protected species are known to inhabit the landfill surface. However, threatened and endangered species, including the salt marsh harvest mouse, may inhabit areas near the landfill.

Nevertheless, because the areal extent of Site 1 is limited, actions taken under Alternative 2 are not likely to jeopardize the continued existence of any endangered species or destroy or adversely modify any endangered species habitats. The landfill cap will protect these habitats by controlling erosion and washout that could otherwise accelerate contaminant migration from the Tidal Area Landfill. Capping the landfill will eliminate exposure pathways resulting from erosion of the landfill surface and will reduce leachate generation by reducing infiltration. In constructing the landfill cap and associated monitoring systems, the Navy will exercise precautions to avoid taking endangered species, mammals, migratory nongame birds, and other birds protected under California law.

#### **Clean Water Act, Section 404 and the 40 CFR Part 230 Guidelines**

Activities relating to wetlands are also regulated under Section 404 of the Clean Water Act and 40 CFR Part 230. Section 404 of the Clean Water Act regulates the discharge of dredged or fill material to waters of the United States. Under the Section 404(b)(1) guidelines, no discharge of fill material is permitted if a practicable alternative exists that would have a less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. Proposed actions under Alternative 2 would not affect wetlands. However, should any

impact to wetlands be anticipated during the remedial design and remedial action phases, the Navy will comply with the substantive requirements of Section 404.

Because proposed cap construction activities will be in close proximity to wetland areas, the following engineering practices commonly used to reduce the potential impact to wetlands will be in place:

- Sensitivity training for subcontractors working on the site.
- Construction of temporary silt collection fences around the landfill perimeter to control sediment and surface water migration into the wetland during cap construction activities.
- Stockpiling of soil away from the wetland boundaries.
- Conducting construction activities during the dry season, to minimize runoff.

Should any impact to the wetlands be anticipated during future remedial design or during remedial action activities, the following contingency actions would be proposed:

- Notify the U.S. Army Corps of Engineers and the Natural Resource Trustees.
- Restore wetland to pre-construction condition.
- Meet substantive requirements specified within the Clean Water Act, Section 404, regarding the discharge of fill material into waters of the United States.

Prior to constructing the landfill cap along the western perimeter of the landfill, landfill refuse will be removed and consolidated within the landfill. Consolidation activities will utilize the engineering controls listed above to prevent or minimize disturbance to wetlands.

Construction of the landfill cap will not affect adjacent Tidal Area wetlands and will comply with the requirements of the Clean Water Act. The landfill cap will protect the adjacent wetlands by reducing erosion and washout that could accelerate contaminant migration into these wetlands.

### **Coastal Area Statutes**

The Coastal Zone Management Act (CZMA) (CZMA, 16 USC 1451, et seq.) requires that all federal activities affecting the coastal zone be conducted in a manner consistent (to the maximum extent practicable), with approved state management programs. The approved coastal zone management plan for San Francisco Bay includes the McAteer-Petris Act, California Government Code Section 66600 et seq., which created the San Francisco Bay Conservation and Development Commission. The BCDC

has developed the San Francisco Bay Plan. The McAtteer-Petris Act and the Bay Plan were developed primarily to halt uncontrolled development and filling of the bay. Their broad goals include reducing fill and disposal of dredged material in the bay and maintaining the water quality of the bay. Construction of a landfill cap will meet these goals and will conform to the substantive requirements of the state management program. The landfill cap will protect the adjacent coastal zone by reducing erosion and washout from the Tidal Area Landfill. The proposed monitoring programs for groundwater and landfill gas will assist in maintaining the existing overall quality of the coastal zone.

#### **4.2.2 Action-Specific ARARs for Site 1 - Tidal Area Landfill**

Action-specific ARARs are applicable to the selected remedy for the Tidal Area Landfill. The Tidal Area Landfill FS recommended selecting a native soil cap as the preferred alternative to address the site. Table 4-2 summarizes the action-specific ARARs for construction of a native soil cap at the Tidal Area Landfill.

#### **4.2.3 TBCs for Site 1 - Tidal Area Landfill**

TBCs for the Tidal Area Landfill are discussed below and are summarized in Table 4-3.

#### **Executive Order 11988, Flood Plain Management**

This executive order directs federal agencies to avoid adverse impacts associated with the occupancy and modification of flood plains and to avoid adverse effects associated with direct and indirect flood plain development. Actions within a flood plain should avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values of the flood plain. The landfill cap would allow surface flow across the landfill towards the wetland in an evenly distributed flow pattern and minimize erosion. Landfill capping will not adversely affect the flood plain or be incompatible with flood plain development. Therefore, this alternative complies with this TBC.

#### **Executive Order 11990, Protection of Wetlands**

Activities relating to wetlands are regulated under Executive Order 11990, Protection of Wetlands. This executive order requires federal agencies to avoid, to the extent possible, the adverse impacts associated with destruction or loss of wetlands and to avoid support of new construction in wetlands, if a practicable alternative exists. Wetlands are defined in Executive Order 11990 as those areas inundated by surface or groundwater with a frequency sufficient to support, under normal

circumstances, a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated conditions for growth or reproduction. Proposed jurisdictional wetlands do not exist within the Tidal Area Landfill since the landfill has been delineated as an upland area (annual/ruderal upland complex). However, jurisdictional wetlands, including “salt marsh” and “seasonal brackish/salt marsh mosaic” habitats, do exist immediately adjacent to the Tidal Area Landfill boundaries (WESCO 1995). In designing and constructing the landfill cap and associated monitoring systems, the Navy will exercise precautions to avoid adversely affecting the adjacent wetland areas.

#### **4.3 PRELIMINARY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED FOR SITE 2 - R AREA DISPOSAL**

The subsections below evaluate and identify preliminary chemical- and location-specific environmental ARARs and TBCs that may be pertinent to the R Area Disposal Site.

##### **4.3.1 Chemical-Specific ARARs for Site 2 - R Area Disposal**

Chemical-specific ARARs provide specific numeric contaminant levels for various environmental media. The media that may be affected by the R Area Disposal Site include soil, sediment, and surface water. Table 4-4 lists the preliminary chemical-specific ARARs for the R Area Disposal Site.

##### **Soil and Sediment**

No federal or state action levels have been promulgated for chemical concentrations in soils or sediment. Therefore, there are no chemical-specific ARARs for soil or sediment at the R Area Disposal Site.

##### **Surface Water**

Water quality objectives from the San Francisco Bay Region Basin Plan, dated June 1995, are applicable to surface water affected by the R Area Disposal. In addition, ambient water quality criteria (AWQC) are considered potentially relevant and appropriate.



#### **4.3.2 Location-Specific ARARs for Site 2 - R Area Disposal**

The location-specific ARARs identified for the Tidal Area Landfill are also ARARs for the R Area Disposal Site. No other location-specific ARARs have been identified for the R Area Disposal Site. See Section 4.2.1 for a discussion of the location-specific ARARs and requirements.

#### **4.3.3 Action-Specific ARARs for Site 2 - R Area Disposal**

No action-specific ARARs were identified for the R Area Disposal Site.

#### **4.3.4 TBCs for Site 2 - R Area Disposal**

The two TBCs are (1) Executive Order 11990, Protection of Wetlands and (2) Executive Order 11988, Floodplain Management. These are the same TBCs identified for the Tidal Area Landfill. These TBCs are discussed in detail in Section 4.2.3

### **4.4 PRELIMINARY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED FOR SITE 9 - FROID AND TAYLOR ROADS**

The subsections below evaluate and identify preliminary chemical- and location-specific environmental ARARs and TBCs that may be pertinent to the for the Froid and Taylor Roads Site.

#### **4.4.1 Chemical-Specific ARARs for Site 9 - Froid and Taylor Roads**

Chemical-specific ARARs provide specific numeric contaminant levels for various environmental media. The media that may be affected by the Froid and Taylor Roads Site include soil, sediment, and surface water. Table 4-4 lists the preliminary chemical-specific ARARs for the Froid and Taylor Roads Site.

##### **Soil and Sediment**

No federal or state action levels have been promulgated for chemical concentrations in soils or sediment. Therefore, there are no chemical-specific ARARs for soils or sediment at the Froid and Taylor Roads Site.

## **Surface Water**

Water quality objectives from the San Francisco Bay Region Basin Plan, dated June 1995, were applicable to surface water affected by the Froid and Taylor Roads Site. In addition, AWQCs are considered potentially relevant and appropriate.

### **4.4.2 Location-Specific ARARs for Site 9 - Froid and Taylor Roads**

The location-specific ARARs identified for the Tidal Area Landfill are also ARARs for the Froid and Taylor Roads Site. No other location-specific ARARs have been identified for the Froid and Taylor Roads Site. See Section 4.2.1 for a discussion of the location-specific ARARs and requirements.

### **4.4.3 Action-Specific ARARs for Site 9 - Froid and Taylor Roads**

No action-specific ARARs were identified for the Froid and Taylor Roads Site.

### **4.4.4 TBCs for Site 9 - Froid and Taylor Roads**

The two TBCs are (1) Executive Order 11990, Protection of Wetlands and (2) Executive Order 11988, Floodplain Management. These are the same TBCs identified for the Tidal Area Landfill. These TBCs are discussed in detail in Section 4.2.3

## **4.5 PRELIMINARY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED FOR SITE 11 - WOOD HOGGER**

The subsections below evaluate and identify preliminary chemical- and location-specific environmental ARARs and TBCs that may be pertinent to the Wood Hogger Site.

### **4.5.1 Chemical-Specific ARARs for Site 11 - Wood Hogger**

Chemical-specific ARARs provide specific numeric contaminant levels for various environmental media. The media that may be affected by the Wood Hogger Site include soil and surface water. Table 4-4 lists the preliminary chemical-specific ARARs for the Wood Hogger Site.

## **Soil**

No federal or state action levels have been promulgated for chemical concentrations in soils. Therefore, there are no chemical-specific ARARs for soils at the Wood Hogger Site.

## **Surface Water**

Water quality objectives from the San Francisco Bay Region Basin Plan, dated June 1995, are applicable to surface water affected by the Wood Hogger Site. In addition, AWQCs are considered potentially relevant and appropriate.

### **4.5.2 Location-Specific ARARs for Site 11 - Wood Hogger**

The location-specific ARARs identified for the Tidal Area Landfill are also ARARs for the Wood Hogger Site. No other location-specific ARARs have been identified for the Wood Hogger Site. See Section 4.2.1 for a discussion of the location-specific ARARs and requirements.

### **4.5.3 Action-Specific ARARs for Site 11 - Wood Hogger**

No action-specific ARARs were identified for the Wood Hogger Site.

### **4.5.4 TBCs for Site 11 - Wood Hogger**

The two TBCs are (1) Executive Order 11990, Protection of Wetlands and (2) Executive Order 11988, Floodplain Management. These are the same TBCs identified for the Tidal Area Landfill. These TBCs are discussed in detail in Section 4.2.3.



## **5.0 GEOLOGY, HYDROLOGY, AND HYDROGEOLOGY OF THE TIDAL AREA SITES**

The following sections describe the geology hydrology and hydrogeology of the focus Tidal Area Site 1 - Tidal Area Landfill Site, Site 2 - R Area Disposal Site, Site 9 - Froid and Taylor Roads Site, and Site 11 - Wood Hogger Site. The regional geology, hydrology and hydrogeology, are discussed in Sections 2.5.2 and 2.5.3, respectively.

### **5.1 GEOLOGY OF THE TIDAL AREA SITES**

This section discusses the geology of the Tidal Area sites and includes lithologic results from both the RI and SI. The geology of the Tidal Area at NWS SBD Concord is characterized by complex sedimentary features. Detailed logs of boreholes drilled in the Tidal Area aid in interpreting the direct influence of the sedimentary features on the surface and groundwater pathways within each site. Logs for boreholes drilled during the RI are included in Appendix F. Logs for boreholes drilled during the SI are included in the investigation report for the Tidal Area (IT 1992). Logs for boreholes drilled for the "Confirmation Groundwater Sampling Technical Memorandum" are in Appendix C of that document. The boring locations used to construct geologic cross sections are shown on Figure 5-1.

As discussed in Section 2.5.3, the geology of the Tidal Area is characterized by fine-grained Bay sediments that consist chiefly of Bay Mud, with isolated lenses of peat, silty sand, and artificial fill material. The Tidal Area sites share a similar history of sedimentary deposition. Artificial fill and Bay Mud were the only hydrogeologic units encountered at the Tidal Area sites during the SI and RI. The hydrogeologic units present in the Tidal Area are described in Section 2.5.3.

Approximately one-half of the Tidal Area sites is overlain by fill material. Fill areas are distinguished by their higher elevation compared to the low-lying wetlands and lithologic dissimilarity with natural tidal area sediments. Fill material typically contains a higher proportion of gravel, sand, yellow and brown clays, and refuse. In many cases, artificial fill consisting primarily of silty clay or silty gravel has been used to construct road beds, levees, and pads for structures. The road beds, levees, and structure pads make each of the Tidal Area sites geographically distinct: these elevated fill features form the site boundaries of the R Area Disposal, Froid and Taylor Roads, and Wood Hogger Sites, and the extent of refuse defines the boundary of the Tidal Area Landfill.

Four geologic cross sections have been developed to illustrate the subsurface geology at the Tidal Area sites. Figure 5-1 shows the transect lines for the geologic cross sections. Figures 5-2 through 5-5 present geologic cross-sections E-E' through H-H', respectively. The cross sections are referred to in the site-specific geologic discussions presented below.

#### **5.1.1 Geology of Tidal Area Landfill Site**

The Tidal Area Landfill forms an asymmetric mound elevated above both the R Disposal Area wetlands to the west and Johnson Road to the east. The highest point (13 feet above msl) is located in the north-central part of the landfill, and the landfill slopes away to the southwest. The western boundary of the landfill is marked by a sharp escarpment, delineating the lateral extent of filling. Subsurface materials encountered while drilling boreholes for the SI and RI indicate that landfill refuse consisting of soil, waste, and construction debris is present at the Tidal Area Landfill Site at depths of at least 11 feet bgs (1 foot bgs above msl) (cross-sections E-E' and H-H', Figures 5-2 and 5-5).

Landfill soil borings indicate that landfill refuse was placed atop imported soils in some areas. For example, soil boring TLS-7 in the center of the landfill contains sandy silt with small pebbles between 8 to 10 feet bgs. This material was likely imported to the site because the Bay Mud, which makes up the subsurface beneath the landfill, consists of silty clay. Peat zones are also present in many borings drilled in the landfill. These zones probably denote natural wetland deposits or landfill disposal of organic materials such as landscaping waste. The lower portion of borings TLSMW004 and TLSMW005 reportedly contain soils that were used to backfill the former artificial sluice and to construct the roadbed for Johnson Road.

The landfill overlies naturally deposited Bay Mud, which consists primarily of dark gray to black silty clay with some discrete lenses of peat and silty sand. The Bay Mud extends from the base of the landfill to at least 20 feet bgs at boring B9, the deepest boring drilled at the landfill (cross-section H-H', Figure 5-5).

The sand lenses visible on cross-section H-H' typically appear to have short lateral extent; most are recorded in a single soil boring and were not encountered in adjacent borings. The only sand lenses that could be correlated between adjacent borings occur near the eastern margin of the landfill. Two of the shallow sand lenses encountered in boring B9 correlate with similar bodies in piezometer PZ-6 (Figure 5-5).

While three new piezometers were being installed east of the landfill, deeper sand body of limited lateral extent was encountered at depths of approximately 6 to 14 feet below msl (cross section E-E', Figure 5-2).

The deeper sand body was encountered in piezometers PZ-3, PZ-4, and PZ-6, but was not encountered in boring B9. The sand body consists of a 3- to 3.5-foot-thick, medium-grained, brown sand that flowed into the augers during drilling in the eastern two borings. In contrast, the sand units encountered in PZ-6 at the eastern margin of the landfill were very fine-grained, silty, and thin, and did not flow into the augers during drilling. The deeper of the three sands in piezometer PZ-6 has been tentatively correlated to the sand body in PZ-3 and PZ-4 and is interpreted as the margin of a discontinuous sand unit that grades laterally westward into silty clay. The lateral extent of this sand body east of piezometers PZ-3 and PZ-4 is unknown.

#### **5.1.2 Geology of the R Area Disposal Site**

The geology of the R Area Disposal site is illustrated in cross-sections E-E', G-G', and H-H' (Figures 5-2, 5-4, and 5-5). Subsurface soils encountered at the R Area Disposal Site consist primarily of Bay Mud. Silty clay is present at the surface over most of the site and was encountered up to a depth of 25 feet bgs (16 feet below msl).

The perimeter of the R Area Disposal Site is overlain with artificial fill. The fill includes the road base around the site and refuse disposed of adjacent to the roads along the western and northwestern perimeter of the site. The refuse consists of wood, metal, and construction debris, which is visible at a few locations. Fill material consisting primarily of soil rather than refuse was encountered in borings drilled along the west and northeast sides of the site (cross-sections G-G' and H-H', Figures 5-4 and 5-5). The distribution of soil fill material encountered in these areas of the R Area Disposal Site is consistent with the fill history developed from Tidal Area aerial photographs from pre-1950 to 1952 (represented on Figures 2-2 and 2-3). The soil fill is characterized by elevated ground surface and yellow or brown silty clays or silty sands.

Bay Mud is present at the surface over most of the site, and extends to depths of at least 16 feet below msl, (the total explored depth at the site). Bay Mud in the R Disposal Area consists primarily of dark gray to black silty clay with abundant organic material (peat). A 2-foot thick silty, sand lens was

encountered at boring RDS-17 (cross-section E-E', Figure 5-2). This lens does not appear to be laterally extensive.

### **5.1.3 Geology of the Froid and Taylor Roads Site**

The geology of the Froid and Taylor Roads Site consists primarily of Bay Mud overlain in some areas by artificial fill. The geology of the western margin of the Froid and Taylor Roads Site is illustrated in cross-section H-H' (Figure 5-5).

Bay Mud is present at the surface over most of the site, and was encountered at depths up to 18 feet below msl, the total explored depth at the site. Bay Mud in the R Disposal Area consists primarily of brownish black, silty clay with abundant organic material (peat). The silty clay becomes sandy at the south end of the site, near well FTSMW001. Metallic refuse was identified at the site during the IAS, but was not visible during the RI.

### **5.1.4 Geology of the Wood Hogger Site**

Soil encountered during the SI and RI borehole drilling at the Wood Hogger Site and SWMU 37 indicates that the subsurface consists mainly of artificial fill with underlying fine-grained Bay Mud. Geologic cross-sections G-G', F-F', and H-H' (Figures 5-3 through 5-5) illustrate the subsurface stratigraphy at the Wood Hogger Site. The site is characterized by a relatively thick layer of artificial fill overlying naturally deposited Bay Mud. In contrast to other Tidal Area sites, the Bay Mud is rarely present at the surface of the Wood Hogger Site. Artificial fill material at the site is heterogeneous, consisting primarily of decayed wood chips and gravel, silty sand, and clayey sand, which form a surficial layer up to 9 feet thick. In most parts of the site, the artificial fill material is 3 to 5 feet thick. At SWMU 37, clay fill was encountered at the surface of all boring locations to a total explored depth of 6 feet bgs. Refuse such as wood scraps, gravel, paving materials, nails, and other metal objects was observed at the surface throughout the site.

The artificial fill material over Bay Mud, which consists primarily of dark gray to black silt or silty clay. The Bay Mud grades laterally into a sandy clay near the western and eastern margins of the site. The Bay Mud extends from approximately sea level to 20 feet below msl, which is the deepest interval penetrated by borings at the site.



### **5.1.5 Summary of the Geology at the Tidal Area Sites**

The subsurface of the four Tidal Area sites and SWMU 37 consists of sedimentary features that reflect the complex depositional environment of tidal wetlands and subsequent modification with roadways, buildings, and drainage features. The Tidal Area is characterized by fine-grained Bay Mud that consists chiefly of silty clay, with isolated lenses of peat and silty sand. The Bay Mud is overlain in some areas by artificial fill used to construct road and railroad beds, channel levees, structural pads, and protective revetments. Because the original surface of the tidal marsh was probably 2 to 3 feet above msl, most of the material above 2 to 3 feet is likely to be fill material. Fill material underlies all of the roads, railroad tracks, and buildings near the Tidal Area sites and much of the Wood Hogger Site. The fill material is a mixed lithology that contains varying proportions of clay, silt, sand, and gravel. The fill material consists mainly of clays; however, sand and gravel were also used for fill. At the landfill, refuse material and construction debris has been found up to 11 feet thick, and soil fill has been encountered at depths up to 10 feet below msl. At the Wood Hogger Site, wood chips make up a significant proportion of the fill material. Metal and wood debris was also encountered in much of the fill material at the other Tidal Area sites.

Until the Tidal Area facilities were built, a natural slough flowed through the present areas of each of the Tidal Area sites. Before the Navy acquired the site, a manmade sluice was constructed through what is now the Tidal Area Landfill and the R Area Disposal Sites. Most of the natural slough and the manmade sluice have been backfilled with soil. Although coarse-grained materials were used to backfill these areas, the coarse-grained material is not continuous, and the water table is below the base of the slough and sluice during most of the year. Consequently, it is unlikely that the slough or sluice act as preferential groundwater flow pathways for large distances.

## **5.2 HYDROLOGY AND HYDROGEOLOGY OF THE TIDAL AREA SITES**

The variability of the natural sediments and drainage features, coupled with large-scale modifications of the Tidal Area environment, create a complex hydrological environment, as presented in the following section. The following sections describe the surface water hydrology and subsurface hydrogeology at the Tidal Area sites. Section 5.2.1 presents the results of the Tidal Influence Survey, which provided empirical data that aid in understanding the overall site hydrology and hydrogeology. Section 5.2.2 describes the overall hydrology and hydrogeology of each of the Tidal Area sites. Surface water and monitoring well locations gauged during the RI are shown on Exhibit 1.

The hydrogeology and surface water hydrology at the Tidal Area sites are strongly influenced by the geologic setting and surface features described in the previous sections. The direction of groundwater flow within the Tidal Area sites is strongly influenced by permanent surface water features such as Otter Sluice, which provides a local source of surface water drainage and groundwater recharge. Infiltration of surface water in the Tidal Area is largely inhibited by the clayey composition of the subsurface soil.

### **5.2.1 Tidal Influence Survey Results**

A tidal influence survey was conducted in June 1994 to assess the effects of tidal fluctuations in Suisun Bay and Otter Sluice on surface water and groundwater elevations at the Tidal Area sites. The one-way tide gate at the end of the Otter Sluice gate is designed to allow flow to exit Otter Sluice while preventing inflow during high tide. During the winter of 1994-1995, after the tidal influence study was conducted, repairs were made to the one-way tide valve. Alteration of the tide valve is expected to have significantly influenced the tidal fluctuation of surface water in Otter Sluice. Prior to the repairs, significant leakage was observed from the flap valve and gate structure. Although the tide gate was repaired, surface water still flows into Otter Sluice through the tide gate during high tide, indicating that the gate does not function with 100 percent effectiveness. If the condition of the tide gate has not significantly degraded since the repairs were made 4 years ago, the fluctuation of surface water elevations in Otter Sluice should be somewhat muted relative to those observed during the June 1994 tidal influence study. If the tide gate continues to degrade without repair, the magnitude of tidal fluctuations will increase in Otter Sluice. The 1994 tidal influence survey and results are described in the following paragraphs.

During the 1994 tidal influence survey, water levels were monitored in eight monitoring wells, five surface locations in Otter Sluice, and one surface location within each of the R Area Disposal, Froid and Taylor Roads, Wood Hogger Sites, and Suisun Bay. Surface water and groundwater levels were measured at locations across the Tidal Area sites, and monitoring well locations were also selected to monitor wells screened in either Bay Mud or fill. Water level measurement locations for the Tidal Influence Survey are shown on Figure 3-1. Table 5-1 provides summaries of survey results. Appendix G includes graphs of water levels over time for the monitoring wells and surface water locations that were monitored during the tidal influence survey.

The tidal influence survey was conducted in June 1994. Water levels were recorded at 15-minute intervals over the course of 1 week at the 17 above-referenced locations using data loggers and pressure transducers. The data loggers recorded changes in water levels at each location. The initial water level at each location was set at 0.00 feet.

During the survey, 5.67 feet of tidal change was recorded in Suisun Bay near tidal gate at measurement location SW-0. Surface water levels at the monitoring locations in Otter Sluice (SW-1, SW-2, SW-5, SW-7, and SW-8) varied in response to tidal fluctuations in Suisun Bay; however, the magnitude of water level change in Otter Sluice decreased with increased distance from Suisun Bay. The maximum change in water level at monitoring location SW-1 across the tidal gate from SW-0, adjacent to the Bay, was 2.45 feet during the monitoring period. At location SW-8, approximately 5,800 feet upstream of SW-1, a maximum water level change of 0.56 feet was recorded during the survey. Tidal fluctuations at SW-8 lagged approximately 5 hours behind those at SW-0. The tide gate reduces the magnitude of tidal influence on water levels in Otter Sluice, as evidenced by the difference in water level fluctuations at locations SW-0 and SW-1.

Water levels at monitoring location SW-3 in the R Disposal Area showed sinusoidal variation at the same frequency as in Otter Sluice, with a lag of several hours. Monitoring locations SW-4 and SW-6, located in the north part of the Froid and Taylor Roads Site and at the western edge of the Wood Hogger Site, exhibited diurnal water level fluctuations of up to 0.5 feet. Over the duration of the survey, water levels at locations SW-3 and SW-4 exhibited a general decreasing trend of 0.26 and 0.15 feet, respectively. The general decreasing trend of surface water levels within the site boundaries may reflect a 0.20-foot decrease in the mean daily surface water level in Suisun Bay over the course of the survey, or may reflect the typical drying pattern during the summer months.

Water level fluctuations were observed in most of the wells that were monitored during the tidal influence survey. The water levels in wells RADMW003 and WHSMW003 exhibited regular changes that reflect tidal fluctuations. These wells are located within approximately 60 feet of Otter Sluice, which appears to locally influence groundwater levels. Well RADMW004, which is also located about 60 feet from Otter Sluice, did not exhibit tidal fluctuations, suggesting that lithology influences the lateral reach of tidal fluctuations in Otter Sluice. Wells RADMW002 through RADMW005 exhibited overall gradual decreases in water levels, which probably reflects continual lowering of the water table during the dry summer months. Decreases in groundwater elevations in these wells during the course of the survey ranged from 0.07 to 0.65 feet. Wells TLSMW002, FTSMW003, and WHSMW002 did

not exhibit significant regular fluctuations in water levels or longer-term changes in water levels. These wells are located 5,500 to 1,300 feet from Otter Sluice and are 1,900 to 3,200 feet from Suisun Bay.

In summary, the tidal influence survey indicates that tidal fluctuations in Suisun Bay caused fluctuations in surface water levels in Otter Sluice from 0.56 feet to 2.45 feet. The magnitude of fluctuations in Otter Sluice decreased with distance inland from the Bay. Minor tidal influence was also observed at one surface water location within the Tidal Area sites (SW-3), and diurnal fluctuations were observed at two other locations (SW-4 and SW-6). Long-term decreases in surface water elevation were observed at all surface water locations within the Tidal Area beyond Otter Sluice. The long-term decreases are due to evaporation and groundwater flow together lowering the groundwater table during the summer months. Regular fluctuations in groundwater elevations were observed in two wells within 60 feet of Otter Sluice. These fluctuations imply that groundwater gradients and flow directions in portions of the sites close to Otter Sluice are also influenced daily by the tides, although well RADMW004, also located 60 feet from Otter Sluice, did not exhibit tidally-related water level fluctuations. Long-term decreases in groundwater levels were observed in several wells, and probably reflect dewatering of the shallow water-bearing zone during the summer months. The dewatering is irregular, because four of the wells did not experience long-term declines in water level.

### **5.2.2 Hydrology and Hydrogeology of the Tidal Area Sites**

This section discusses the hydrology and hydrogeology of the Tidal Area sites. The following conditions influence the hydrology of the Tidal Area sites:

- Upland areas provide groundwater recharge for the lowland areas in the Tidal Area.
- Artificial barriers to surface water flow have been constructed. These barriers include drainage channel levees, raised road beds (railroad and motor vehicle), berms, and elevated areas structure pads.

Areas of ponded water have been created by the above-listed barriers. These ponds, both ephemeral and continuous, serve as groundwater recharge points.

The natural slough that drained the present Tidal Area sites was supplanted by manmade drainage features. Most of the slough was backfilled, although some portions remain. The backfilled slough and the former manmade sluice are not expected to act as a subsurface conduit because the portions of

these features were backfilled with low permeability materials. As a consequence, the backfilled slough and sluice do not form a continuous high permeability pathway for groundwater flow. Further, the water table is below the base of the slough for most of the year, so the backfill material is typically unsaturated.

Tidal fluctuations in Suisun Bay and Otter Sluice influence surface water and groundwater at some areas of the site.

The natural sediments at the site consist of low-permeability clays interspersed with thin, discontinuous permeable zones. The stratigraphy of the site is fairly anisotropic, which increases the complexity of groundwater movement at the site.

Artificial fill covers approximately one-half of the total acreage of Tidal Area sites. The composition and thickness of the artificial fill is highly variable, but permeabilities of the fill are likely to be greater than those of the native sediments.

Groundwater and surface water elevations at the Tidal Area sites were measured in July 1995, October 1995, January 1996, and April 1996. Groundwater and surface water elevations for the four measurement events are presented in Tables 5-2 and 5-3, respectively. Water levels throughout the sites were measured within a 2-hour period during each measurement event. Water levels were measured first at locations with the greatest tidal fluctuations, such as Otter Sluice, and progressed to locations with minimal tidal influence. This approach served to maximize comparability of the water level measurements.

Groundwater and surface water elevations for the four measurement events are illustrated on Figures 5-6 through 5-9. Potentiometric surfaces were contoured using both the groundwater and surface water elevations. The tidal influence study demonstrated that surface water and groundwater at the sites are hydrologically connected in the area adjacent to Otter Sluice. Information presented on the water level contour maps and the cross sections are discussed in the following site-specific sections.

#### **5.2.2.1 Hydrology of the Tidal Area Landfill**

The hydrogeology of the Tidal Area Landfill Site is strongly influenced by the presence of artificial fill, which covers the entire site. The surface of the artificial fill is found at heights up to 13 feet above the adjacent, low-lying wetlands of the R Area Disposal Site. Surface water infiltrates rapidly through the

permeable landfill material but is slowed by the fine-grained, low-permeability Bay Mud at the base of the fill material. Groundwater elevation data were obtained from seven groundwater monitoring wells surrounding the Tidal Area Landfill Site (TLSMW001 through TLSMW007), but not from within the landfill itself. The data indicate that groundwater elevations east of the landfill (wells TLSMW004 and TLSMW005) are consistently higher than those at the western edge of the landfill and the R Area Disposal Site and that groundwater flows from east to west beneath the landfill. Groundwater is interpreted to move westward from the Tidal Area Landfill Site toward the R Area Disposal Site (Figures 5-6 through 5-9), except in the northern portion of the landfill, where groundwater flows northward toward Suisun Bay.

Groundwater elevations at the Tidal Area Landfill Site during the four measurement events ranged from 3.18 feet below msl (well TLSSMW001, October 1995) to 2.77 feet above msl (well TLSMW005, January 1996). Except for well TLSMW002, water levels in the wells at the site were uniformly highest in January 1996, (the height of the wet season), followed by April 1996 (end of the wet season), July 1995 (beginning of the dry season), and October 1995 (end of the dry season) (Table 5-2). The response of water levels in landfill wells to seasonal rainfall indicates that groundwater is recharged by infiltration of precipitation.

Well TLSMW002 exhibited an apparent lag in water level response to seasonal rainfall. The highest water level in TLSMW002 occurred in April rather than January. This apparent lagged response to the rainy season may be the result of the location of well TLSSW002. The well is located 120 feet from the landfill in a low-lying terrain that remains flooded into the dry season. The persistent surface water near the well head may cause water levels in well TLSMW002 to be highest at the end of the wet season rather than in the middle of the wet season.

#### **5.2.2.2 Hydrology of the R Area Disposal Site**

The hydrology of the R Area Disposal Site is influenced by geomorphologic features and by tidally influenced artificial and natural channels. As discussed in Section 5.2.1, tidal fluctuations of water levels in Suisun Bay influence surface water in Otter Sluice, which in turn influences the surface water and, to a lesser extent, the groundwater within the R Area Disposal Site. During high tide, water flows from Suisun Bay into Otter Sluice and into the low-lying parts of the R Area Disposal Site via two culverts that run underneath Baker Road at the western boundary of the R Area Disposal Site. During extreme tidal events (for example when spring tides coincide with storms), surface water from Otter

Sluice flows overland across Baker Road into the R Area Disposal Site and subsequently drains into Otter Sluice through the two culverts. Surface water that drains from the R Area Disposal Site ultimately discharges into Suisun Bay. Surface water exchange between the R Area Disposal Site and Otter Sluice is most prevalent during the rainy season.

Most of the R Area Disposal Site consists of low-permeability Bay Mud. Heavy rainfall, abundant surface water inflows, and low evaporation rates cause flooding over large areas of the site during the wet season. During the dry season, surface water infiltration is reduced and evaporation increases; however, some areas remain flooded (Figure 2-7). These seasonal fluctuations directly influence the groundwater and surface water elevations within the R Area Disposal Site. The interpreted water level contours at the site (Figures 5-6 through 5-9) illustrate that the groundwater recharge from Otter Sluice is most pronounced in the dry season, when groundwater levels within the site are relatively low.

To determine seasonal groundwater and surface water trends, groundwater levels at the R Area Disposal Site were measured in seven groundwater monitoring wells (RADMW001 through RADMW007) and two piezometers (RADPZ001 and RADPZ002), and surface water levels were measured at two surface gauges (RADSG007 and RADSG008). Potentiometric surfaces for the wet and dry seasons (Figures 5-6 through 5-9) share the same general features. Groundwater elevations are generally highest at the end of the wet season and lowest during the dry season, but groundwater flowed radially toward a depression in the water table in the R Area Disposal Site during all four measurement events. Groundwater elevations are below sea level over large parts of the R Area Disposal Site and are higher along the perimeter of the site throughout the year, indicating that groundwater flows from the edges of the Tidal Area sites toward the center. Groundwater elevations in the R Area Disposal Site ranged from 3.15 feet below msl (well RADMW001, October 1995) to 3.14 feet above msl (well RADMW004, January 1996). Groundwater does not appear to discharge to Suisun Bay via subsurface flow or groundwater and surface water interaction, although limited groundwater and surface water interaction occurs along a narrow strip adjacent to Otter Sluice, as discussed in Section 5.2.1.

Groundwater levels in wells RADMW001, RADMW004, and RADMW005 were highest in January 1996 and lowest in October 1996, following the progression of seasonal rainfall (Table 5-2 and Figure 5-12). This behavior may indicate good communication between the surface and the subsurface at these locations where wells were installed in areas of fill material. The highest water levels in the remaining wells lag the rainy season by several months. These wells are situated in wetland areas that

are flooded for many months out of the year. The persistent presence of surface water in the vicinity of these wells likely causes water levels to be highest at the end of the rainy season. The presence of standing water also indicates less permeable soil: boring logs for these wells indicate silty clays from the surface to the bottom of the screen. This decreased soil permeability could create the lag time observed in the response of groundwater levels to precipitation cycles. Groundwater levels in wells RADMW002 and RADMW003 vary over a smaller annual range than other wells at the site due to their proximity to Otter Sluice.

Surface water measurements from two gauging locations, RADSG004 and RADSG008, are strongly correlated with seasonal rainfall (Table 5-3). Surface water levels measured in the natural slough at gauging location RADSG007 showed poor correlation with seasonal rainfall, with the highest water levels in July 1995 and the lowest in April 1996 (Table 5-3).

#### **5.2.2.3 Hydrology of the Froid and Taylor Roads Site**

The hydrology of the Froid and Taylor Roads Site is controlled primarily by surface features such as roads that create barriers for surface water movement and cause ponding. Fill material is present at the surface in at least one-half of the site. As discussed in Section 5.2.2.1, precipitation infiltrates rapidly into the porous and highly permeable fill sediments that underlie the roads. However, infiltration rates are slowed by the fine-grained, low-permeability Bay Mud. Groundwater is interpreted to move westward from fill areas along Froid and Taylor Roads toward the low-lying wetlands areas in the Froid and Taylor Roads Site and the Wood Hogger Site. The tidal influence survey showed very modest diurnal variations and a gentle long-term decline in water level in the remnant of the natural slough that was monitored. The natural slough remnant does not appear to be tidally influenced.

To determine seasonal groundwater and surface water trends at the Froid and Taylor Roads Site, groundwater measurements were collected from five groundwater monitoring wells (FTSMW001 through FTSMW005) and one surface water gauge (FTSSG010). Groundwater generally flows from east to west at the site; however, a persistent groundwater mound is present in the north-central part of the Froid and Taylor Roads Site and the adjoining Tidal Area Landfill Site (Figures 5-6 through 5-9). The apparent mounding in the northern portion of the site may be exaggerated in the July and October 1995 water level maps because low water levels in the former natural slough during the summer months create a localized depression of the water table (Figure 5-6 and Figure 5-7).



Groundwater elevations at the Froid and Taylor Roads Site during the four measurement events ranged from 1.27 feet below msl (well FTSMW002, October 1995) to 2.42 feet above msl (well FTSMW003, January 1996). Groundwater levels at the site are generally highest in the wet season and lowest during the dry season. Groundwater levels in wells FTSMW001, FTSMW004, and FTSMW005 were highest in January 1996 and lowest in October 1995, following the progression of seasonal rainfall (Table 5-2 and Figures 5-10 and 5-12). This behavior may indicate good communication between the surface and the subsurface at these wells, which were installed in areas of road fill. Water levels in wells FTSMW002 and FTSMW003 show a lag time compared to the rainy season. These wells were also installed in areas where fill is present at the surface; however, these wells are screened primarily in silty clay, which would slow the effects of surface infiltration.

Surface water elevations at gauging location FTSSG010 are also strongly correlated with seasonal rainfall (Table 5-3).

#### **5.2.2.4 Hydrology of the Wood Hogger Site**

The hydrology of the Wood Hogger Site is influenced by Otter Sluice, natural drainages, and groundwater flow from the Froid and Taylor Roads Site. Otter Sluice is adjacent to the west and south sides of the Wood Hogger Site, and a tributary to Otter Sluice is present in the southeast corner of the Wood Hogger Site. Tidal fluctuations of water levels in Otter Sluice exert a localized influence on surface water and groundwater adjacent to the sluice and tributary.

Groundwater and surface water levels at the Wood Hogger Site were measured during four measurement events in wells WHSMW001 through WHSMW004 and surface water gauging stations WHSSG005, WHSSG006, and WHSSG009 to assess seasonal groundwater and surface water variations. Groundwater at the Wood Hogger Site is interpreted to flow generally to the north, toward the R Area Disposal Site during the dry season (Figures 5-6 and 5-7) and toward a water table depression in the south and southeast part of the site during the wet season (Figures 5-8 and 5-9). Otter Sluice appears to recharge groundwater along the south and east boundaries of the site (Figures 5-6 through 5-9). Convolutioned groundwater contours in the eastern area of the site are likely caused by significant differences between surface water elevations at gauging location WHSSG009 and groundwater elevations in Froid and Taylor Roads Site well FTSMW002. These differences in water elevations suggest poor communication between the surface water and groundwater at this location.

Groundwater elevations at the Wood Hogger Site during the four measurement events ranged from 1.01 feet below msl (well WHSMW002, October 1995) to 1.62 feet above msl (well WHSMW004, July 1996). Groundwater levels in well WHSMW002 were highest in January 1996 and lowest in October 1995, following the progression of seasonal rainfall (Table 5-2). This behavior may indicate good communication between the surface water and groundwater at this well, which was installed in a fill area. Well WHSMW001 was also installed in fill material; however, water levels in this well show a significant lag time in responding to seasonal rainfall. Groundwater levels in well WHSMW003 reflected the tidal variations in Otter Sluice (Section 5.2.1) and were poorly correlated with seasonal rainfall. Well WHSMW004 is located adjacent to Otter Sluice, but it is not known whether this well is tidally influenced because the well was not monitored during the tidal influence survey. However, the proximity of Otter Sluice appears to moderate seasonal changes in groundwater levels in well WHSMW004 (Table 5-2).

All surface water measurement points at the Wood Hogger Site are located in Otter Sluice (WHSSG005) or are in direct connection with Otter Sluice (WHSSG006 and WHSSG009), and were influenced by the tides. A low surface water elevation in gauging location WHSSG009 caused an apparent depression in the piezometric surface during the April 1996 gauging event (Figure 5-9).

#### **5.2.2.5 Summary of the Hydrology and Hydrogeology of the Tidal Area Sites**

Numerous conditions at the Tidal Area affect the hydrology of the sites. The Tidal Area is a highly modified physical environment consisting of low-lying areas interrupted by elevated features constructed of artificial fill, such as levees, road beds, building pads, and disposal areas. These elevated features act as barriers to surface flow and cause ponding in some areas. They also serve as areas of relatively rapid infiltration and groundwater mounding. Site soils mainly consist of low-permeability silty clays that generally inhibit surface water infiltration. The subsurface silty clays are interspersed with thin, discontinuous permeable fill zones. The complex morphology of the permeable zones creates areas of local complexity in groundwater flow.

Except for the Tidal Area Landfill, surface water is present at all sites during the rainy season. At the R Area Disposal and the Wood Hogger Sites, surface water is present continuously in some areas. Surface water levels in Otter Sluice are strongly influenced by tidal variations in Suisun Bay. In turn, surface water levels in ponded areas that are connected to Otter Sluice are tidally influenced.

Groundwater at the Tidal Area sites generally flows radially toward the center of the R Area Disposal Site. The piezometric surface is highly irregular because of the variability of soil permeabilities, the presence of standing and perched water, and the complexities of the present and filled drainage systems. Groundwater levels in some areas of the R Area Disposal and Wood Hogger Sites near Otter Sluice respond to tidal fluctuations and long-term changes in surface water levels in Suisun Bay and Otter Sluice.



## **6.0 CHEMICAL CHARACTERIZATION OF THE TIDAL AREA SITES**

The following sections present the chemical characterization of the Tidal Area sites based on the analytical results of samples collected during the RI, the RFA confirmation study investigation of SWMU 37 and the "Confirmation Groundwater Sampling Technical Memorandum" (TtEMI 1998b). Specifically this section presents chemical characterization of the Tidal Area sites relative to human health screening criteria, whereas chemical characterization of the Tidal Area sites relative to ecological screening criteria, is presented in Volume II of the RI. The focus of the Tidal Area RI was to collect and analyze surface and subsurface soil samples for use in a screening risk assessment and to identify potential sources and release mechanisms used to develop the conceptual site models presented in this section. In addition, the RI at the Tidal Area Landfill Site (Site 1) perimeter and the adjoining area of the R Area Disposal Site (Site 2) was conducted to assess whether chemicals may be migrating from the Tidal Area Landfill Site to the R Area Disposal Site. Consistent with EPA guidance, the presumptive remedy approach is being followed at the Tidal Area Landfill Site, so the RI did not attempt to further characterize the contents of the landfill.

Soil, sediment, unfiltered surface water, and groundwater samples were collected during the RI and subsequent studies. All soil, sediment and surface water locations sampled during the RI and the RFA Confirmation Study investigation of SWMU 37 are shown on Exhibit 1. Groundwater samples collected and analyzed for the "Confirmation Groundwater Sampling Technical Memorandum" are discussed in detail in the technical memorandum and summarized in this RI. Table 6-2 summarizes the analyses performed on samples collected at the Tidal Area Landfill Site, R Area Disposal Site, Froid and Taylor Roads Site, Wood Hogger Site, and SWMU 37 in 1998. Complete analytical results are presented in the analytical results table in Volume III of this RI, Appendices A through D. All of the soil, sediment and surface water analytical results are usable as qualified. The analytical results tables also include detection limits and data qualifiers for each sample result.

Statistical summaries of the analytical results for soil and sediment collected at the Tidal Area Landfill Site, R Area Disposal Site, Froid and Taylor Roads Site and Wood Hogger Site (with SWMU 37) are presented in Tables 6-3 through 6-6. For purposes of this RI, there is no distinction made between soil and sediment samples, and results are presented in the same statistical summary tables and discussed collectively in text. In the QEA report (Volume II), sediment samples are those taken at Otter Sluice locations (OSL designation). Analytical results from these sediment locations were used to further

characterize Otter Sluice for the ecological risk assessment, and were not used for the HHRA in Section 7.0 of this RI.

Statistical summaries of the analytical results of surface water collected at each of the Tidal Area sites except the landfill (Site 1) are presented in Tables 6-7 through 6-19. Tables 6-7 through 6-10 present the results of four rounds of surface water sampling for the R Area Disposal Site, Tables 6-11 through 6-15 present results of five rounds of the surface water sampling for the Froid and Taylor Roads Site and Tables 6-16 through 6-19 present the results of four rounds of the surface water sampling for the Wood Hogger Site.

The tables list detected chemicals, concentration ranges, detection frequencies, and numbers of samples with chemical concentrations exceeding human health screening criteria at each site. Ecological screening and ecological risk evaluation of the data is presented in Volume II of the RI. The results of analyses conducted exclusively for evaluating ecological risk (such as bioassay tests and sediment sample analyses) are presented only in Volume II.

Screening criteria assist in evaluating the RI results because they were used to determine whether contaminants detected in the various media were at concentrations of potential concern. The screening criteria used to characterize the nature and extent of contaminants at the tidal area sites are the EPA Region IX PRGs for residential soil and tap water (Appendix J; EPA 1996), and estimated ambient metals concentrations developed from metal concentrations in Tidal Area soil (Appendix E). Generally, the nature and extent of an organic compound in soil and sediment is discussed principally if the analytical result exceeds the residential PRG concentration. The nature and extent of a specific metal in soil is discussed if the analytical result exceeds the PRG and the estimated ambient metal concentration. Surface water analytical results are compared to the tap water PRGs. The above-listed criteria were used to determine chemicals of potential concern (COPC) that are considered in the HHRA, Section 7.0. COPCs listed in Section 7.0 are based on soil and surface water samples; sediment samples taken from Otter Sluice for the QEA were not included in the HHRA. The COPCs are further analyzed in the HHRA to develop a list of risk drivers.

Iron was detected in all soil and sediment samples from all four Tidal Area sites. Typically, concentrations detected fell below the estimated ambient concentration for the Tidal Area sites and above the PRG. As is discussed in Section 7.0 of this RI, a level of iron causing adverse effects in normal individuals has not been quantitatively determined (National Academy of Science [NAS] 1989).

The PRG that has been established for iron (22,000 milligrams per kilogram [mg/kg]) has not been through the formal EPA process, and it is likely that individuals may be exposed to iron at levels significantly higher than the PRG without experiencing adverse effects. Iron is not considered a COPC in this report, and is not discussed separately for each site or included in Exhibit 3.

## **6.1 CHEMICAL CHARACTERIZATION OF THE TIDAL AREA LANDFILL SITE**

The following sections present the chemical characterization of the perimeter of the Tidal Area Landfill Site based on the analytical results for samples collected during the RI.

### **6.1.1 Overview of Laboratory Analyses**

A total of 24 surface and subsurface samples were collected from eight borings around the perimeter of the landfill and submitted for analysis during the RI (Exhibit 1). The soil samples were collected in July and August 1995 and were analyzed for VOCs (subsurface samples only), SVOCs, pesticides and PCBs, explosive compounds, and inorganic chemicals. All samples collected from the perimeter of the Tidal Area Landfill were analyzed for hexavalent chromium.

Surface water was not collected at the Tidal Area Landfill Site during the RI because no surface water exists on the landfill; however, surface water samples were collected from the R Area Disposal Site at two locations within 100 feet of the landfill perimeter. The analytical results for the samples collected from these surface water locations, RADSW014 and RADSW017, are presented with the results for the R Area Disposal Site in Section 6.2.

### **6.1.2 Results of Soil and Sediment Sample Analyses**

Organic and inorganic compounds were detected in analytical results of sampled soil and sediment. A summary of the organic and inorganic chemicals detected in soil and sediment collected around the Tidal Area Landfill Site during the RI is presented below. Complete analytical results for the soil and sediment samples are presented in Table A-1 of Appendix A. Statistical summaries of chemicals detected in soil and sediment are provided in Table 6-3.

#### **6.1.2.1 Organic Compounds in Soil**

Organic compounds, including VOCs, SVOCs (including PAHs), and pesticides and PCBs, were detected in the soil samples collected around the landfill (Appendix A). The frequencies of detection

and distribution of these compounds are discussed below. Explosive compounds were not detected in any soil samples. Exhibit 2 presents soil sampling locations with organic compounds concentrations exceeding PRGs.

## VOCs

VOCs were detected in at least one soil sample collected from all borings at the Tidal Area Landfill Site except soil boring TLSSB006. Surface soil samples were not analyzed for VOCs because it was assumed that VOC would have volatilized from surface soil. VOCs were detected in soil samples at concentrations ranging from 10 to 580  $\mu\text{g}/\text{kg}$  and at depths between 1.3 to 5.8 feet bgs. However, except for chloromethane, the VOC detected in the samples were either common laboratory contaminants (acetone and 2-butanone) or carbon disulfide, which occurs naturally in bay environments. Chloromethane was detected in one sample collected from each of soil borings TLSSB001, TLSSB003, and TLSSB005 at depths ranging from 3.9 to 5.5 feet bgs and at concentrations up to 48  $\mu\text{g}/\text{kg}$ . Acetone, 2-butanone, and carbon disulfide were detected in samples at concentrations up to 580, 390, and 120  $\mu\text{g}/\text{kg}$ , respectively. None of the VOC concentrations exceeded residential PRGs.

## SVOCs

SVOCs, including PAHs, were detected in soil samples collected from all soil borings at the Tidal Area Landfill Site. SVOCs were detected at concentrations up to 19,000  $\mu\text{g}/\text{kg}$  (phenol, in the sample collected from soil boring TLSSB004, at 1.3 to 2.4 feet bgs). The PAH benzo(a)pyrene was detected in a surface sample collected from soil boring TLSSB004 at a concentration of 68  $\mu\text{g}/\text{kg}$ , which slightly exceeds the residential PRG of 56  $\mu\text{g}/\text{kg}$  but does not exceed the industrial PRG of 360  $\mu\text{g}/\text{kg}$  (Exhibit 2). Soil boring TLSSB004 is located at the westernmost margin of the landfill. No other SVOC concentrations exceeded residential PRGs. Samples collected from soil boring TLSSB004 contained 14 other SVOCs at concentrations ranging from 100 (mg/kg) to 19,000 ( $\mu\text{g}/\text{kg}$ ). Most of the SVOCs detected at the site were in surface soil samples.

The source of SVOCs in soil collected at the perimeter of the Tidal Area Landfill is unknown, but may be the result of past disposal practices at the site or from off-site sources. SVOCs are found in fuels, oils, asphalt, and wood preserved with creosote (observed at the surface from soil boring TLSSB005), all of which may have been disposed of at the landfill. Airborne deposition of wood smoke and vehicle



exhaust are major sources of PAHs in the environment (U.S. Department of Health and Human Services 1993) and may be potential off-site sources.

### **Pesticides and PCBs**

Pesticides and PCBs were detected in soil samples from soil borings at the Tidal Area Landfill Site. In total, 12 pesticides were detected at concentrations up to 27  $\mu\text{g}/\text{kg}$  (surface sample from soil boring TLSSB001), and 18 Aroclors and PCB congeners were detected at concentrations ranging up to 47  $\mu\text{g}/\text{kg}$  (soil boring TLSSB001 and surface sample from soil boring TLSSB002). No pesticide or PCBs concentration exceeded residential PRGs. DDT compounds were the pesticides most frequently detected in soil samples, and at the highest concentrations. Pesticides may be present at the Tidal Area Landfill as a result of past mosquito abatement practices.

#### **6.1.2.2 Inorganic Chemicals in Soil**

Metals were detected in all 24 soil samples collected at the Tidal Area Landfill Site. Table 6-3 summarizes the range of metals concentrations in soil samples and the frequency of detections exceeding the screening criteria. The metals aluminum, antimony, beryllium, cadmium, chromium, copper, mercury, nickel, vanadium, and zinc were detected in soil samples collected at the Tidal Area Landfill Site at concentrations exceeding Tidal Area estimated ambient metals concentrations for soil, but less than the respective residential PRGs. Samples collected from all of the boreholes contained at least one metal at concentrations greater than the estimated ambient concentrations, with the surface samples generally containing the highest metals concentrations. The surface sample collected from soil boring TLSSB004 contained the highest site concentrations of barium, molybdenum, nickel, and lead, and the surface sample collected from soil boring TLSSB007 contained the highest site concentrations of antimony, arsenic, lead, and silver.

Arsenic and lead were detected at concentrations exceeding residential PRGs. The detection frequencies and distribution of these metals are discussed below. Exhibit 3 presents soil sampling locations where concentrations of arsenic and lead exceeded the PRGs and the estimated ambient metals concentrations.

## **Arsenic**

Arsenic was detected in all 24 soil samples obtained at the Tidal Area Landfill Site at concentrations up to 57.6 mg/kg (surface sample from soil boring TLSSB007). Although all 24 of the samples contained arsenic at concentrations exceeding the residential PRG of 0.38 mg/kg, only 3 of these samples exceeded the estimated ambient concentration for arsenic of 27 mg/kg.

## **Lead**

Lead was detected in 22 of 24 soil samples obtained at the Tidal Area Landfill Site at concentrations ranging from 5.3 to 156 mg/kg. The surface soil samples collected from soil borings TLSSB002 and TLSSB007 contained lead at concentrations of 152 and 156 mg/kg, respectively, which exceed the estimated ambient concentration of 95 mg/kg and the California DTSC modified residential PRG of 130 mg/kg. However, these concentrations did not exceed the EPA residential PRG of 400 mg/kg. Lead detected at concentrations exceeding estimated ambient at the perimeter of the landfill may be the direct result of site disposal of materials such as lead-acid batteries, construction materials, and paints.

### **6.1.3 Summary of Chemical Characterization**

The following summarizes the results of soil sampling and analysis in the R Area Disposal Site at the boundary of the Tidal Area Landfill Site.

#### **6.1.3.1 Organic Compounds in Soil**

Low concentrations of VOCs were detected in soil samples from all borings but one at the Tidal Area Landfill Site; however, except for chloromethane, the VOCs detected in the samples were either common laboratory contaminants (acetone and 2-butanone) or carbon disulfide, which occurs naturally in bay environments. None of the VOC concentrations exceeded residential PRGs. The presence of low levels of VOCs in landfill soil may be the result of past disposal activities at the site.

No pesticides or PCBs exceeded the residential PRGs; however, pesticides and PCBs were detected in soil from six of eight soil sampling locations, primarily in surface soil samples. The source of pesticides and PCBs is unknown but may be related to past disposal activities or application of mosquito abatement chemicals at the site and surrounding area.

SVOCs, including PAHs, were detected in soil samples collected from all landfill perimeter borings. Only one SVOC, the PAH benzo(a)pyrene, was detected at a concentration exceeding the residential PRG (surface sample from soil boring TLSSB004). Although the source of SVOCs at the landfill perimeter is unknown, SVOCs may be the result of (1) petroleum products or creosote-treated wood disposed of in the landfill (observed at the surface at soil boring TLSSB005), (2) airborne deposition of vehicle exhaust and wood smoke, or (3) petroleum products used in mosquito abatement pesticides in the Tidal Area.

Explosives were not detected in any of the RI soil samples.

#### **6.1.3.2 Inorganic Chemicals in Soil**

Arsenic and lead were detected in soil samples collected at the perimeter of the Tidal Area Landfill at concentrations greater than estimated and residential PRGs. Lead in soil at concentrations exceeding soil screening criteria may be the result of prior site activities, especially given the variety of household, construction, and industrial waste believed to have been disposed of at the site (Section 2.7.1).

#### **6.1.4 Revised Conceptual Site Model for Tidal Area Landfill Site**

The revised conceptual site model, shown on Figure 6-1, is based on the conceptual model for the Tidal Area Landfill Site presented in the work plan. The revised conceptual site model incorporates RI information and lists potential sources and chemicals of concern, and highlights the most likely migration routes (PRC and Montgomery Watson 1995).

The Tidal Area Landfill was formed by the placement of soil and waste debris extending outward in a Southwesterly direction from Johnson Road. It is unlikely that excavation occurred before the fill was placed, and historical photographs indicate that the fill material was placed on the marsh surface and spread out from the road over a 20-year period. The northwest and southwest boundaries of the site are defined for the RI as the edge of the fill escarpment, which is 4 to 6 feet above the surface of the larger area west of the landfill itself. The surface of the landfill is now covered by soil, with various metal and timber debris protruding from the soil. A number of holes in the soil surface were caused by debris, animal burrow, or subsidence. No evidence of chemical waste disposal is currently visible, although asbestos and paint wastes are alleged to have been disposed of there.

The major migration pathways for chemical movement from the Tidal Area Landfill are (1) eroding surface soil containing adsorbed chemicals and (2) water infiltrating and dissolving soluble chemicals below the surface of the landfill. Although there are no known sources of volatile chemicals, transport and exposure to asbestos and other chemicals via windblown and water-borne soil is of potential concern; however, this potential pathway is eliminated once the landfill is capped under the presumptive remedy. Evaporation and rehydration is not considered a pathway of concern for the landfill because surface water does not exist on the landfill. Currently, conditions exist where water leaching through the uncapped landfill may exit through the fill and debris escarpment at the landfill perimeter. Water migrating downward would eventually reach the Bay Mud, which underlies the landfill. Once at the saturated and relatively impermeable Bay Mud surface, the water is presumed to flow laterally along the surface until it reaches the edge of the landfill, and exfiltrates as surface water. A small amount of the water may move into the Bay Mud.

RI analytical results do not indicate that chemicals are migrating from the landfill into the R Area Disposal Site. Only one surface water sample collected next to the landfill (surface water sample RADSW014) contained nickel and copper at concentrations greater than the screening criteria. The origin of these metals in surface waters may be the landfill or may be from chemical concentration due to ponding and evaporation. The results of surface water sampling within the R Area Disposal Site are more thoroughly discussed in the following sections of this report.

## **6.2 CHEMICAL CHARACTERIZATION OF THE R AREA DISPOSAL SITE**

The sampling and analytical results for the R Area Disposal Site are summarized below. Data were gathered using both purposive and unbiased sampling approaches. In the purposive approach, samples were collected at suspected disposal locations that were identified in previous site investigations. In the unbiased approach, samples were collected from additional locations to provide uniform spatial coverage of the site.

### **6.2.1 Overview of Sampling Approach**

Soil samples were collected at the surface and subsurface of the R Area Disposal Site during the RI. Samples of the upper layer of sediment were collected from Otter Sluice. Surface water samples were collected from permanent and ephemeral bodies of water. Soil, sediment and surface water sampling locations are shown in Exhibit 1.

#### **6.2.1.1 Soil and Sediment**

Soil was sampled at the R Area Disposal Site in July and August 1995. Unbiased grid sampling of surface soil was conducted to define site-wide variances in soil chemical concentrations. As stated in the work plan, each grid section measured 200 feet by 200 feet based on the overall size of the site and the number of sampling locations (grid nodes) believed necessary to represent the site (PRC and Montgomery Watson 1995). Unbiased subsurface samples were collected at randomly selected grid nodes to assess the soil chemical concentrations at depth. Focused (biased) soil sampling was conducted at locations where evidence of disposal activities were observed or reported in earlier investigations. Field contingency samples were collected based on site conditions observed at the time of sampling, for example, stained soil or newly encountered disposal areas.

Sediment samples were collected from Otter Sluice....**FINISH**

#### **6.2.1.2 Surface Water**

Four rounds of surface water sampling were conducted during the RI at the R Area Disposal Site. Surface water was collected in July 1995, October 1995, January 1996, and April-May 1996 at 17†locations, including sloughs, continually flooded areas, and ephemeral ponds on the site; and from Otter Sluice adjacent to the site.

Surface water samples were also collected from Otter Sluice in the 1998 sampling event. The 1998 surface water sampling results for Otter Sluice are presented in the QEA portion of this report (Volume II).

#### **6.2.2 Overview of Laboratory Analyses**

During the RI, surface and subsurface soil samples and surface water samples were collected throughout the site. Soil samples were analyzed for SVOCs, pesticides and PCBs, and inorganic constituents. Subsurface soil samples were analyzed for VOCs. Several soil samples were also analyzed for explosive compounds and hexavalent chromium. The surface water samples from the R Area Disposal Site were analyzed for VOCs, SVOCs, pesticides and PCBs, explosives, and inorganic constituents (unfiltered).

### **6.2.3 Results of Soil and Sediment Sample Analyses**

Organic and inorganic constituents were detected during the RI in soil and sediment collected at the R Area Disposal Site. The results of organic and inorganic analyses are presented in the sections below. Complete analytical results for soil and sediment samples are presented in Appendix B, Table B-1. A statistical comparison of soil and sediment analytical results and the screening criteria is presented in Table 6-4.

#### **6.2.3.1 Organic Compounds in Soil**

Organic compounds, including VOCs, SVOCs, and pesticides and PCBs were detected in soil samples collected at the R Area Disposal Site. The frequency of detection and distribution of the detected compounds in soil are discussed below. Exhibit 2 presents the locations of samples with concentrations of organic compounds that exceed the PRGs. Explosives compounds were not detected in any soil samples.

##### **VOCs**

Low concentrations of VOCs were detected in subsurface soil samples collected from the R Area Disposal Site. (Surface soil samples were not analyzed for VOCs.) VOCs were detected in soil samples at depths between 1.2 to 6.0 feet bgs; however, except for chloromethane, the VOCs detected in the samples were either 2-butanone (up to 73  $\mu\text{g}/\text{kg}$ ), a common laboratory contaminant, or carbon disulfide (up to 160  $\mu\text{g}/\text{kg}$ ), which occurs naturally in bay environments. Chloromethane was detected in one sample (soil boring RADSBH06, 1.5 to 2.0 feet bgs) at a concentration of 14  $\mu\text{g}/\text{kg}$ . Carbon disulfide was detected in four samples at concentrations up to 160  $\mu\text{g}/\text{kg}$ , and 2-butanone was detected in two samples at maximum concentration of 73  $\mu\text{g}/\text{kg}$ , respectively. No VOC concentrations exceeded residential PRGs. The distribution of VOC concentrations does not show a pattern suggestive of a potential source.

##### **SVOCs**

SVOCs, including PAHs, were detected in surface and subsurface soil samples at concentrations greater than the residential PRGs. SVOCs were detected at concentrations exceeding residential PRGs in soil samples collected from two areas in the R Area Disposal Site: the northwestern portion of the site along Otter Sluice and Baker Road, and at the south edge of the site along an unnamed drainage

feature that runs parallel to Froid Road, approximately 200 feet north of Froid Road (Exhibit 2). Evidence of past disposal activities has been documented at both areas of the site. The PAH benzo(a)pyrene was detected in samples collected from eight borings at concentrations exceeding the residential PRG for benzo(a)pyrene (56  $\mu\text{g/kg}$ ). Benzo(a)pyrene was detected at concentrations up to 1,500  $\mu\text{g/kg}$  (grid sample collected from soil boring RADSBG08, 0.7 to 2 feet bgs). The sample collected from soil boring RADSBG08, 0.7 to 2 feet bgs, also contained the PAHs benzo(a)anthracene (2,000  $\mu\text{g/kg}$ ), benzo(b)fluoranthene (2,300  $\mu\text{g/kg}$ ) and benzo(k)fluoranthene (820  $\mu\text{g/kg}$ ) at concentrations exceeding the residential PRGs for these SVOCs (560, 560, and 610  $\mu\text{g/kg}$ , respectively). Soil boring RADSBG08 is located along the above-referenced drainage channel approximately 150 feet north of Building R-1 along the southern margin of the R Area Disposal Site. No SVOCs were detected in the samples collected from soil boring RADSBG08 at the surface or at depth (4.0 to 5.3 feet bgs), indicating a limited extent of subsurface contamination at this location. The PAH dibenz(a,h)anthracene were detected in purposive surface samples collected from soil borings RADSB007 and RADSB008 at concentrations of 87 and 94  $\mu\text{g/kg}$ , respectively, which exceed the residential PRG value of 56  $\mu\text{g/kg}$ .

Twenty-five additional SVOCs were detected in soil samples collected from the R Area Disposal Site at concentrations ranging from 96 to 1,100  $\mu\text{g/kg}$ , but less than residential PRGs. These SVOCs were detected primarily in soil samples collected at the margins of the site where evidence of waste disposal is most frequent. These areas include the northwest and south margins of the site, as well as the northeastern and southwestern areas of the site. Except for one cluster of samples (soil borings RADSBG04 through RADSBG06, and RADSBH04), SVOCs were not detected in samples collected from the interior of the R Area Disposal Site. The results of SVOC sampling do not indicate that SVOCs in the Tidal Area Landfill soil have migrated to the surface and subsurface soil of the R Area Disposal Site.

Elevated concentrations of PAHs in soil samples collected from the margins of the site may be the result of past waste disposal, or airborne deposition and subsequent runoff of wood smoke and vehicle exhaust particulates. Runoff of diesel exhaust residue from roadways is a major source of PAHs in the environment (Moore and Ramamoorthy 1984).

## **Pesticides and PCBs**

Low concentrations of pesticides and PCBs were detected in 56 of 67 soil samples collected at the R Area Disposal Site. None of the pesticide or PCB concentrations exceeded the respective residential PRGs. DDT compounds were the pesticides detected most frequently and at the greatest concentrations. DDT compounds were detected in 61 of 67 surface samples, with total DDT concentrations up to 73  $\mu\text{g}/\text{kg}$  (soil boring RADSB011). Surface samples collected from purposive borings RADSB010 and RADSB011 contained the highest concentrations of DDT compounds at the site. The unbiased grid surface samples collected in the north-central portion of the site (near RADSB010 and RADSB011) also contained several pesticide compounds at somewhat elevated concentrations. Eight pesticides other than DDT were detected in surface samples collectively, at concentrations up to 3  $\mu\text{g}/\text{kg}$  (alpha-chlordane in soil boring RADSB005). The ubiquity of pesticides in surface soil at the R Area Disposal Site may be the result of past widespread application of mosquito abatement chemicals at the site and surrounding area; however, pesticides in samples collected from purposive borings RADSB010 and RADSB011 indicate that pesticides may be present at some areas of the site due to past disposal activities. Due to the random selection of subsurface sample locations, no subsurface samples were collected from soil borings RADSB010 and RADSB011. However, pesticides were not detected at any of the locations where subsurface samples were collected.

PCBs were detected in 56 of the 67 surface samples at total concentrations up to 13  $\mu\text{g}/\text{kg}$  (soil boring RADSB003). PCBs were detected in surface samples collected throughout the site, although no distribution pattern is apparent. PCBs were not detected in the subsurface samples.

### **6.2.3.2 Inorganic Chemicals in Soil**

Table 6-4 summarizes the metals concentrations in soil and sediment samples and the frequency of detections exceeding the screening criteria. The following inorganics were detected in soil and sediment samples collected at the R Area Disposal Site at concentrations above estimated ambient metal concentrations, but below the respective residential PRGs for soil: aluminum, antimony, beryllium, cobalt, copper, mercury, molybdenum, thallium, vanadium, and zinc. The metals arsenic, barium, chromium, lead, manganese, nickel, and were detected in soil collected from the R Area Disposal Site at concentrations exceeding residential PRGs. The detection frequencies and distribution of these metals are discussed below. Exhibit 3 presents concentrations of metals that were detected above PRGs, along with sampling locations.



## **Arsenic**

Arsenic was detected in 128 of the 133 soil and sediment samples collected at the R Area Disposal Site at concentrations ranging from 2.3 to 47.2 mg/kg. Although all 128 of the samples contained arsenic concentrations exceeding the residential PRG of 0.38 mg/kg, only 1 subsurface and 7 surface soil samples contained arsenic at concentrations exceeding the Tidal Area estimated ambient concentration for arsenic of 27 mg/kg. Three of eight samples with arsenic concentrations greater than the ambient concentration value were collected in areas of known disposal. However, of the 30 purposive sampling locations within the R Area Disposal Site, only three samples had arsenic concentrations greater than the ambient concentration value. This lack of elevated arsenic concentrations associated with known disposal areas, in combination with ubiquitous arsenic detections in most of the soil samples, does not suggest the presence of an arsenic source of in the R Area Disposal Site.

## **Barium**

Barium was detected in all 133 soil and sediment samples collected at the R Area Disposal Site. One sample, the unbiased surface sample collected from soil boring RADSBE07, in the south-central portion of the site (Exhibit 3), contained barium at a concentration of 7,710 mg/kg, which exceeded the estimated ambient concentration of 530 mg/kg and the residential PRG for barium of 5,300 mg/kg. No fill or debris was observed in the soil from soil boring RADSBE07; however, barium at this location may be the result of surface water ponding and evaporation cycles.

## **Chromium**

Chromium was detected in 126 of 133 soil and sediment samples collected at the R Area Disposal Site at concentrations up to 319 mg/kg. Fifteen soil samples contained chromium at concentrations exceeding the estimated ambient concentration of 82.1 mg/kg. Chromium was detected in the surface sample collected from soil boring RADSBA07 (319 mg/kg) at a concentration exceeding the residential total chromium PRG of 210 mg/kg. Elevated concentrations of chromium were in the central portion of the site detected mainly in surface samples, potentially indicating an anthropogenic source.

## **Lead**

Lead was detected in 132 of 133 soil and sediment samples obtained at the R Area Disposal Site. Twenty-two of the samples contained lead at concentrations exceeding the Tidal Area estimated

ambient concentration of 95 mg/kg and 14 samples contained lead at concentrations exceeding the residential PRG of 130 mg/kg. The maximum lead concentration was 1,160 mg/kg detected in a random grid sample collected from soil boring RADSBG08 at a depth range of 0.7 to 2.0 feet bgs. This sample, RADSBG08, also contained the highest SVOC concentrations at the site. Soil samples containing elevated lead concentrations were found in the central area of the site at a distance from the margins of the site and known areas of waste disposal. However, the presence of elevated lead concentrations primarily in surface soil indicates an anthropogenic source. Additional soil samples collected in the northwest and southwest corners of the site at known areas of waste disposal contained elevated lead concentrations. This suggests that the area around soil boring RADSBG08 may have received undocumented waste.

### **Manganese**

Manganese was detected in all 133 soil and sediment samples collected at the R Area Disposal Site. The surface and subsurface (1.5 to 2.0 feet bgs) soil samples collected from RADSB108 contained manganese at concentrations of 2,090 and 6,300 mg/kg, respectively, which exceeded the estimated ambient concentration of 1,500 mg/kg. The manganese concentration in the subsurface sample collected from RADSB108 exceeded the residential PRG of 3,100 mg/kg. RADSB108 is located along the south margin of the site, but it is not in an area of known waste disposal.

### **Nickel**

Nickel was detected in all 133 soil and sediment samples obtained at the R Area Disposal Site. Five samples (four surface and one subsurface) contained nickel at concentrations exceeding the estimated ambient concentration of 120 mg/kg. One soil sample collected from soil boring RADSBH06 (1.5 to 2.0 feet bgs) contained nickel at concentration exceeding the DTSC-modified residential PRG of 150 mg/kg. No samples exceeded the EPA residential PRG of 1,500 mg/kg. The distribution of elevated nickel concentrations in site soil does not show a discernible pattern.

## **6.2.4 Results of Surface Water Analyses**

Surface water samples were collected at the R Area Disposal Site RI during four sampling events: July 1995, October 1995, January 1996, and April-May 1996. Samples were collected from 17 locations (Exhibit 5); however, because of seasonal conditions, water was not present at all sampling locations during each sampling event. Complete analytical results for surface water samples collected

at the site are presented in Appendix B, Table B-3. Surface water analytical results were screened against the PRG for tap water. Tables 6-6 through 6-9 summarize the compounds detected in surface water samples for the four sampling events.

#### **6.2.4.1 Organic Compounds in Surface Water**

Surface water samples from the R Area Disposal Site were analyzed for VOCs, SVOCs, pesticides, and PCBs and explosives. The VOC chloromethane was detected in the sample collected in July 1995 at Otter Sluice surface water location RADSW001 at a concentration of 11  $\mu\text{g/L}$ , which exceeded the tap water PRG of 1.5  $\mu\text{g/L}$ . Several pesticide compounds were detected in at least one surface water sample at concentrations exceeding the screening criteria. No SVOCs or explosive compounds were detected in surface water samples collected at the site.

#### **6.2.4.2 Inorganic Chemicals in Surface Water**

Surface water samples from the R Area Disposal Site were analyzed for unfiltered CLP inorganics (major cations and metals). Twelve metals, including aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, thallium, and zinc, were detected at concentrations above the screening criteria.

Except for arsenic, no inorganic constituents were detected at concentrations exceeding the screening criteria in surface water samples collected from Otter Sluice adjacent to the R Area Disposal Site. Elevated concentrations of metals in surface water were generally detected in samples collected from the documented disposal areas in the northwestern corner, western perimeter, and south perimeter of the site. Many of the elevated concentrations were detected in samples collected from the area of the former natural slough; however, the results do not indicate that the former slough is an undocumented disposal area. Instead, results indicate that the former slough is an area where metals most likely concentrate due to evaporation.

#### **6.2.5 Summary of Chemical Characterization**

The following sections summarize the chemical characterization for soil, sediment, and surface water at the R Area Disposal Site.

#### **6.2.5.1 Soil**

Organic and inorganic chemicals were detected in soil samples collected at the R Area Disposal Site at concentrations exceeding residential PRGs.

##### **Organic Compounds in Soil**

SVOCs, including PAHs, were detected in surface and subsurface soil samples at concentrations greater than residential PRGs. These SVOCs are benzo(a)pyrene, dibenz(a,h)anthracene, benzo(a)anthracene, benzo(b)fluoranthene, and benzo(k)fluoranthene. Soil samples with SVOC concentrations exceeding residential PRGs were collected in two areas of the R Area Disposal Site: the northwestern portion and the south edge of the site. Evidence of past disposal activities has been documented at most of the sampling locations; however, the sample containing the largest variety and highest concentrations of SVOCs was collected from random grid subsurface sample RADS BG08 (0.7 to 2.0 feet bgs). Elevated concentrations of PAHs in soil samples collected from the margins of the site may indicate wastes disposal or may be the result of deposition and runoff of exhaust and wood smoke residues.

No pesticides and PCBs or VOCs were detected in soil samples at concentrations greater than residential PRGs. No explosive compounds were detected in the soil samples.

Soil analytical results do not indicate higher organic compound concentrations in the areas adjoining the Tidal Area Landfill, and therefore do not indicate that organic compounds in the Tidal Area Landfill soil have migrated to the surface and subsurface soil of the R Area Disposal Site.

##### **Inorganic Chemicals in Soil**

The metals arsenic, barium, chromium, lead, manganese, and nickel were detected in soil and sediment samples collected from the R Area Disposal Site at concentrations exceeding residential PRGs. The metals barium, chromium, lead, and manganese were detected at the margins of the site, where evidence of past disposal activities has been documented. For some metals with concentrations exceeding PRGs, the geographic distribution of elevated concentrations does not strongly suggest an anthropogenic source. These metals include nickel and arsenic.

Soil and sediment analytical results do not indicate higher concentrations of metals in the areas adjoining the Tidal Area Landfill, and therefore do not indicate that metals detected in the Tidal Area Landfill have affected the R Area Disposal Site.

#### **6.2.5.2 Surface Water**

Organic and inorganic chemicals were detected in surface water samples collected from Otter Sluice adjacent to the R Area Disposal Site at concentrations exceeding AWQC chronic values.

##### **Organic Compounds in Surface Water**

The pesticide compounds aldrin, dieldrin, heptachlor, and heptachlor epoxide were detected in surface water samples at concentrations that exceeded the tap water PRG screening criterion. However, none of the above-listed pesticide compounds were detected in samples collected during more than one sampling event at the same location. In addition, elevated pesticide concentrations do not exhibit a pattern of distribution that would suggest a source area. No elevated concentrations of pesticides were found in surface water samples collected in the area of the Tidal Area Landfill Site. Chloromethane was detected in one sample from Otter Sluice at a concentration exceeding the screening criteria.

No SVOCs or explosive compounds were detected in surface water samples collected at the site.

##### **Inorganic Chemicals in Surface Water**

Aluminum, arsenic, lead, manganese, and thallium were detected in surface water samples at concentrations above the screening criteria. With few exceptions, no elevated concentrations of metals were found in samples collected at the same location during different sampling events. Arsenic and manganese were the metals most commonly detected at concentrations exceeding the screening criteria. Samples collected from locations along the natural slough, RADSW008, RADSW010, RADSW011, and RADSW013, contained a disproportionate number of metals concentrations that were greater than screening criteria, probably as a result of metals concentrating from ponding and evaporation. The elevated metals concentrations in the sample collected from RADSW005, located along the west side of the site near a known area of disposal, may indicate an anthropogenic source. Except for arsenic, concentrations of metals in Otter Sluice surface water did not exceed screening criteria. Only arsenic was detected in surface water samples collected from Otter Sluice at concentrations above the screening criteria.

#### **6.2.6 Revised Conceptual Site Model for R Area Disposal Site**

The revised conceptual site model shown on Figure 6-2 incorporates RI information into the conceptual model for the R Area Disposal Site presented in the work plan. The revised conceptual site model lists potential sources and chemicals of concern, and highlights the most likely chemical migration routes (PRC and Montgomery Watson 1995). Except for the triangular area in the northwest part of the site bounded by Miller Road and Baker Road which has been filled to a higher elevation, the remainder of the R Area Disposal site is subject to seasonal flooding. The R Area Disposal Site is connected to Otter Sluice by culverts under Baker Road that appear to allow water to drain from the site into Otter Sluice. The culverts are however, gated to minimize water flowing from the sluice into the site. Waste consisting of construction debris along Baker Road and empty ammunition boxes along Pickett Road was observed during site visits and the field investigations. Except for the fill areas, the larger area is a seasonal wetland with no physical evidence of disposal. Because the area floods periodically and the weak marsh surface lacks roadway access to the area, even minor disposal of waste is considered unlikely in the R Area Disposal Site.

The major exposure pathways are expected to be surface soil and surface water, however the quality and extent varies seasonally. Wind transport is not considered a pathway of concern for the R Area Disposal Site. The site consists of surface water and wet, clayey soils; therefore, dust is not expected to be generated. Volatilization is not considered a pathway because of the lack of VOCs detected during the RI. The major migration pathway for chemicals in the R Area Disposal Site is likely surface flow from the seasonally flooded area through the culverts into Otter Sluice. The RI results indicate that the Otter Sluice surface water was not affected by any identifiable source of contamination. However, sediment samples from Otter Sluice did contain benzo(a)pyrene from an unknown source.

#### **6.3 CHEMICAL CHARACTERIZATION OF THE FROID AND TAYLOR ROADS SITE**

The following sections present the chemical characterization of the Froid and Taylor Roads Site based on analytical results for samples collected during the RI. The samples were collected at suspected disposal locations that were identified in previous site investigations, and at additional locations that were intended to provide an approximate uniform spatial coverage of the site. No grid surface sampling was conducted at the Froid and Taylor Roads Site because of its relatively small area compared to the other Tidal Area sites.

### **6.3.1 Overview of Laboratory Analyses**

Soil and sediment samples were collected from 14 locations and analyzed during the RI at the Froid and Taylor Roads Site (Exhibit 1). Twelve locations were analyzed for VOCs, SVOCs, pesticides and PCBs, explosive compounds, TPH-e, hexavalent chromium, and inorganics. Two locations were analyzed for chlordane only.

Surface water samples were collected at the Froid and Taylor Roads Site at two locations during the RI, FTSSW001 and FTSSW002 (Exhibit 1). Surface water was sampled in July 1995, October 1995, January 1996, and April 1996; however, samples were not collected at FTSSW002 in October 1995 and April 1996 because water was not present at those times (Table 6-14). The surface water samples were analyzed for TPH, VOC, SVOC, pesticides and PCBs, explosive compounds, and inorganics.

Table 6-2 lists analytical methods used for each of the soil, sediment, and surface water samples collected at the Froid and Taylor Roads Site in 1998.

### **6.3.2 Results of Soil and Sediment Sample Analyses**

Organic and inorganic chemicals were detected in soil and sediment samples collected. The results of organic and inorganic analyses are summarized below. Complete analytical results for soil and sediment samples are presented in Appendix C, Table C-1. A statistical comparison of soil and sediment analytical results and the screening criteria is presented in Table 6-5.

#### **6.3.2.1 Organic Compounds in Soil and Sediment**

Organic compounds, including VOCs, SVOCs, pesticides and PCBs, and petroleum hydrocarbons were detected in soil and sediment samples at the Froid and Taylor Roads Site. The frequency of detection and distribution of these compounds are discussed below. Exhibit 2 presents the locations of soil and sediment samples with concentrations of organic compounds that exceeded PRGs. Explosive compounds were not detected in any soil and sediment samples.

#### **VOCs**

Only one VOC was detected in the soil samples collected at the Froid and Taylor Roads Site. The VOC 4-methyl-2-pentanone was detected once at a concentration of 27 µg/kg in the sample collected

from soil boring FTSSB005 (2.0 to 3.0 feet bgs), in the eastern portion of the site. The concentration of 4-methyl-2-pentanone was below the residential PRG of 750,000  $\mu\text{g}/\text{kg}$ .

### **SVOCs**

SVOCs were detected in soil samples collected from borings at the Froid and Taylor Roads Site.

SVOCs, including PAHs, were detected in the samples; however, only two samples contained SVOCs at concentrations above residential PRGs. The PAH benzo(a)pyrene was detected in the surface soil samples collected from soil borings FTSSB005 and FTSSB009 at concentrations of 130 and 120  $\mu\text{g}/\text{kg}$  respectively. The residential PRG for benzo(a)pyrene is 56  $\mu\text{g}/\text{kg}$ . FTSSB005 and FTSSB009 are located at the eastern and southeastern portions of the site, between an old road crossing the site and Taylor Road (Exhibit 2).

Detections of SVOC in soil near roadways may be the result of deposition and runoff of auto and diesel exhaust. Samples collected from FTSSB005 and FTSSB009 contained TPH-e quantified as motor oil. Both vehicle emissions and wood smoke are major sources of PAHs in the environment (U.S. Department of Health and Human Services 1993).

### **Pesticides and PCBs**

Pesticides and PCBs were detected in soil samples collected from seven of nine borings at the Froid and Taylor Roads Site (seven surface soil samples and two subsurface soil samples). A total of 12 pesticides and 13 Aroclors and PCB congeners were detected. Pesticide concentrations ranged from 0.3 to 35  $\mu\text{g}/\text{kg}$ , with chlordane isomers exhibiting the highest pesticide concentrations at the site. PCB concentrations ranged from 0.07 to 2.0  $\mu\text{g}/\text{kg}$ . However, none of the pesticide or PCB concentrations at the site exceeded residential PRGs. The surface soil samples collected from FTSSB001 contained the highest concentrations of pesticides at the site. The highest concentrations of PCBs were detected in the surface samples collected from soil borings FTSSB001 and FTSSB003 (Exhibit 2). FTSSB001 is located in the center of an enclosed depression. Ponding and evaporation of surface water may have concentrated pesticides in the area of FTSSB001. FTSSB003 is located near Froid Road in the suspected area of disposal activities identified in the IAS (Section 2.7.3).



## **Petroleum Hydrocarbons**

TPH-e quantified as motor oil was detected in soil samples collected from all borings at the Froid and Taylor Roads Site. TPH-e quantified as motor oil was detected in soil samples at concentrations ranging from 9 to 23,000 mg/kg. The highest concentration of TPH-e quantified as motor oil was detected in a surface sample collected from soil boring FTSSB003, along the south edge of Froid Road (Exhibit 4). An approximate 3-foot by 3-foot area of stained soil was observed during sampling at this location. The surface sample collected from soil boring FTSSB002, also located along the south edge of Froid Road, contained motor oil at a concentration of 7,800 mg/kg. Subsurface soil samples contained TPH-e, quantified as motor oil at concentrations up to 9,200 mg/kg, with the highest concentration in the sample collected from soil boring FTSSB001 (0.35 to 1.3 feet bgs), in the center of the portion of Site 9 north of Froid Road. No residential PRGs are established for diesel or motor oil.

Elevated concentrations of motor oil in the samples collected from FTSSB001 through FTSSB003 are most likely the result of surface releases of diesel fuel or motor oil alongside Froid Road. Lower concentrations of motor oil may be the result of runoff from the roads and railways that traverse the site. TPH-e was not quantified within any other hydrocarbon range (for example, diesel) in the soil samples collected at the site.

### **6.3.2.2 Inorganic Chemicals in Soil and Sediment**

Metals were detected in soil samples collected from all boring locations at the Froid and Taylor Roads Site. Table 6-5 summarizes the range of metals concentrations in soil samples and the frequency of detections exceeding the screening criteria. The metals aluminum, chromium, copper, lead, mercury, vanadium, and zinc were detected in soil samples collected at the Froid and Taylor Roads Site at concentrations exceeding the ambient metal concentrations for Tidal Area soil. Arsenic, lead, and manganese were detected in soil at concentrations exceeding residential PRGs, as described below. Exhibit 3 presents sample locations where lead and manganese were detected above PRGs and 99th percentile ambient concentrations.

#### **Arsenic**

Arsenic was detected in 18 of the 21 soil and sediment samples collected at the Froid and Taylor Roads Site at concentrations ranging from 4.5 to 26.6 mg/kg. All 18 samples contained arsenic at

concentrations exceeding the residential PRG of 0.38 mg/kg. None of the samples contained arsenic at concentrations exceeding the Tidal Area estimated ambient concentration of 27 mg/kg.

### **Lead**

Lead was detected in all 21 soil and sediment samples obtained at the Froid and Taylor Roads Site at concentrations up to 515 mg/kg (FTSSB002). Five soil samples, representing various locations at the site, contained lead at concentrations greater than the Tidal Area estimated ambient concentration of 95 mg/kg. Four soil samples, all collected from the surface at soil borings FTSSB002, FTSSB003, FTSSB006, and FTSSB009, contained lead at concentrations exceeding the residential PRG of 130 mg/kg. These elevated lead concentrations were detected only in surface samples collected adjacent to roadways, which suggests an anthropogenic source (Exhibit 3).

### **Manganese**

Manganese was detected in all 21 soil and sediment samples obtained at the Froid and Taylor Roads Site at concentrations up to 3,530 mg/kg. One sample at location FTSSL104 contained manganese at a concentration greater than the Tidal Area estimated ambient concentration of 1,500 mg/kg and the residential PRG of 3,100 mg/kg (Exhibit 3). This sample was collected in sediment, and so was not evaluated for human health risk in this report. The location of FTSSL104 is not an area of known waste disposal.

### **6.3.3 Results of Surface Water Analyses**

Surface water samples were collected at two locations (FTSSW001 and FTSSW002) during the RI at the Froid and Taylor Roads Site. The surface water samples were collected in July 1995, October 1995, January 1996, May 1996; however, surface water was not present at location FTSSW002 in October 1995 or May 1996 (Table 6-13). Both surface water sample locations are in the area of the site immediately south of Froid Road, near soil sampling locations FTSSB002 and FTSSB003. Surface water samples were also collected at three additional locations during a recent 5th round of sampling in June 1998.

Surface water samples collected at the Froid and Taylor Roads Site during the first four sampling events were analyzed for VOCs, SVOCs, pesticides and PCBs, explosives, and inorganic constituents. Surface water samples were analyzed for SVOCs and inorganics during the June 1998 surface water

sampling. Surface water analytical results were screened against the PRG for tap water. The analytical results for surface water samples collected at the Froid and Taylor Roads Site during the RI are presented in Appendix C, Table C-2. Statistical summaries of surface water analytical results for the five surface water sampling events are presented in Tables 6-10 through 6-14.

#### 6.3.3.1 Organic Compounds in Surface Water

No pesticides and PCBs, or explosives were detected in surface water collected at the site. SVOC constituents were detected in the fifth round of surface water sampling in June 1998, however none of the concentrations exceeded tap water PRGs.

TPH-e was detected in all six surface water samples from the Froid and Taylor Roads Site that were submitted for TPH-e analysis. The TPH-e constituents detected in site surface water samples are listed in the following table. There are no screening criteria for TPH-e constituents.

Constituent	Location ID	Sampling Event	Concentration (mg/L)
Diesel	FTSSW001	Jul 1995	0.3
		Oct 1995	2
		Jan 1996	0.1
		May 1996	< 0.6 (ND)
	FTSSW002	Jul 1995	0.3
		Jan 1996	0.8
Motor Oil	FTSSW001	Jul 1995	0.6
		Oct 1995	2
		Jan 1996	0.2
		May 1996	0.6
	FTSSW002	Jul 1995	0.8
		Jan 1996	0.1

As shown in the table, petroleum hydrocarbon concentrations were highest during dry months (July and October) and lowest during rainy months (January and April), when surface waters receive fresh inputs. No VOC other than carbon disulfide were detected in the samples. Carbon disulfide, a common compound in bay environments, was detected in the sample collected at FTSSW001 in October 1995 at a concentration of 20 µg/L. There is no screening criterion for carbon disulfide.

#### **6.3.3.2 Inorganic Chemicals in Surface Water**

Surface water samples from the Froid and Taylor Roads Site were collected without filtration and analyzed for inorganics.

Arsenic and manganese were consistently detected in samples collected during each of the five sampling events at concentrations exceeding the tap water PRGs at both sampling locations.

#### **6.3.4 Summary of Chemical Characterization**

The following sections summarize the chemical characterization of soil, sediment, and surface water at the Froid and Taylor Roads Site.

##### **6.3.4.1 Soil and Sediment**

Organic and inorganic chemicals were detected in soil and sediment samples collected at the Froid and Taylor Roads Site at concentrations exceeding residential PRGs. The organic and inorganic chemicals detected are discussed below.

##### **Organic Compounds in Soil and Sediment**

No soil or sediment samples collected at the site contained pesticides and PCBs or VOCs at concentrations exceeding residential PRGs. Explosive compounds were not detected in any soil or sediment samples.

SVOCs, including PAHs, were detected in soil and sediment samples at the site. Two samples collected near Taylor Boulevard contained the PAH benzo(a)pyrene at concentrations exceeding the residential PRG. SVOCs detected in soil near roadways may be the result of deposition and runoff of auto and diesel exhaust and wood smoke particulates from road surfaces.

TPH-e quantified as motor oil was detected in soil samples collected from all borings at the Froid and Taylor Roads Site. TPH-e quantified as motor oil was detected in soil samples at concentrations ranging from 9 to 23,000 mg/kg, with the highest concentration of TPH-e, detected in a surface sample collected along the south edge of Froid Road. Relatively elevated concentrations of motor oil in the samples collected from FTSSB001 through FTSSB003 may be indicative of surface releases of diesel fuel or motor oil alongside Froid Road. Lower concentrations of motor oil at the site may be the result

of runoff from the roads and railways that traverse the site. No residential PRGs have been established for diesel or motor oil.

#### **Inorganic Chemicals in Soil and Sediment**

Arsenic, lead, and manganese were the only inorganic constituents detected in soil and sediment samples at concentrations exceeding residential PRGs. Arsenic was detected in nearly all of the soil and sediment samples at concentrations exceeding the residential PRG; however, no sample concentrations exceeded the estimated ambient concentration for arsenic. Lead was detected at concentrations up to 515 mg/kg, exceeding the residential PRG in four surface samples, indicating a likely anthropogenic source. Manganese was detected in one sample exceeding the PRG and ambient concentrations; no source is known.

#### **6.3.4.2 Surface Water**

Organic and inorganic chemicals were detected in surface water samples collected from the Froid and Taylor Roads Site, with concentrations of inorganics exceeding screening criteria. The results are discussed in the following sections.

##### **Organic Compounds in Surface Water**

No pesticides and PCBs, or explosives were detected in surface water collected at the site. The VOC carbon disulfide, a common compound in bay environments, was detected in one sample.

TPH-e quantified as diesel was detected in all surface water samples collected at the site at concentrations ranging from 0.084 to 2.0 mg/L. TPH-e quantified as motor oil was detected in all surface water samples collected at the site at concentrations ranging from 0.11 to 2.0 mg/L. The presence of petroleum hydrocarbons in surface water samples collected at the site may be indicative of surface releases of diesel fuel or motor oil. Lower concentrations of motor oil at the site may be the result of runoff from the roads and railways that traverse the site. No surface water screening criteria have been established for diesel or motor oil.

##### **Inorganic Chemicals in Surface Water**

Over the course of the five sampling events at the Froid and Taylor Roads Site, only arsenic and manganese were consistently detected at concentrations exceeding the tap water PRGs.

### **6.3.5 Revised Conceptual Site Model for the Froid and Taylor Roads Site**

The revised conceptual site model shown on Figure 6-3 incorporates RI information into the conceptual site model for the Froid and Taylor Road Site presented in the work plan (PRC and Montgomery Watson 1995). This revised model lists potential sources, and highlights the most likely chemical migration routes. The Froid and Taylor Roads Site is bounded by roads and by a railroad trestle on the west. The northern portion of the site contains a small, perennially flooded area is a part of the former natural slough that ran through the present area of Tidal Area sites (Section 5.2). Historical photographs show that a road ran through the middle of the site, segments of which are still visible. Although small pieces of metal debris have been observed at the site, and a piece of ordnance was found during the IAS, there is no other visible evidence of chemical releases at the site.

Some of the surface water drains to the south through a culvert under Taylor Roads and then to Otter Sluice upstream of the Wood Hogger site. Not all of the surface water escapes the site. Residual ponded water remains at the site or evaporates and the water level drops during the dry season. Surface waters and surface soils are expected to be the major exposure pathways at the site. Wind transport is not considered a pathway of concern for the Froid and Taylor Roads Site. The site consists of surface water and wet, clayey soils; therefore, dust is not expected to be generated. Volatilization is not considered a pathway because of the absence of VOCs. The major chemical migration pathway at the site appears to be associated with surface water movement. Petroleum hydrocarbons and metals were detected in surface water samples collected from the Froid and Taylor Roads Site.

### **6.4 CHEMICAL CHARACTERIZATION OF THE WOOD HOGGER SITE**

The following sections discuss the analytical results for the Wood Hogger Site based on the analytical results of the RI and the RFA Confirmation Study at SWMU 37, the wood storage and processing site in the central area of the Wood Hogger Site (Exhibit 1). Data were gathered at the Wood Hogger Site using both unbiased and purposive sampling approaches. The samples were collected at suspected disposal locations identified in previous site investigations and at additional locations intended to provide uniform spatial coverage of the site. To evaluate the statistical adequacy of the sampling program in this phase of the RI, the site was generally divided into northern and southern portions physically separated by SWMU 37. Wood chips were disposed of primarily in the southern portion of the site. The former incinerator was also located in the southwestern portion of the site. Most of the northern portion of the site has not been affected by fill or disposal activities and contains areas that are

flooded for significant intervals. Soil sampling locations at SWMU 37 were selected based on present wood storage and processing locations at the site.

#### **6.4.1 Overview of Sampling Approach**

Soil samples were collected at the surface and subsurface of the Wood Hogger Site during the RI and SWMU 37 investigation. Samples of the upper sediment layer were collected from Otter Sluice. Surface water samples were collected from permanent and ephemeral bodies of water. Soil, sediment, and surface water sampling locations are shown in Exhibit 1.

##### **6.4.1.1 Soil**

Soil sampling was conducted at the Wood Hogger Site in July and August 1995 as part of the RI. Unbiased grid sampling of surface soil was conducted to define site-wide variances in soil chemical concentrations. As proposed in the site work plan each grid section measured 200 feet by 200 feet based on the overall size of the site and the number of sampling locations (grid nodes) believed necessary to represent the site (PRC and Montgomery Watson 1994a). Unbiased subsurface samples were collected at randomly selected grid nodes to assess soil chemical concentrations at depth and to determine the depth to Bay Mud at the site. The depth to Bay Mud needed to be defined at this site because of the historical widespread filling of the site during the building of the Wood Hogger infrastructure. Focused (biased) soil sampling was conducted at locations where evidence of disposal activities had been observed. Some field contingency samples were collected based on site conditions observed at the time of sampling, for example, stained soil or newly encountered disposal areas. Surface and subsurface soil were collected at the Wood Hogger Site during the RI. Soil samples were collected in both the fill and Bay Mud. The investigation at SWMU 37 was conducted in April 1995 and involved the collection of soil samples from 18 locations (Exhibit 1).

##### **6.4.1.2 Sediment**

In 1998, sediment sampling was conducted again at Otter Sluice. The purpose of this sampling was to better characterize the chemical concentrations in the sluice for the QEA. Analytical results for this sampling are used in the QEA (Volume II), and were not used in the HHRA for the RI. Sediment results from Otter Sluice were not considered for the HHRA because there is no apparent exposure pathway for residential or industrial scenarios.

#### **6.4.1.3 Surface Water**

Four rounds of surface water sampling were conducted during the RI. Surface water was collected in July 1995, October 1995, January 1996, and May 1996 at three locations in continually flooded areas within the Wood Hogger Site and at three locations in Otter Sluice adjacent to the site. Each of these six surface water samples and four sampling events were included in the RI HHRA screening. In 1998, surface water sampling was conducted again at Otter Sluice. The 1998 Otter Sluice analytical results were not screened in the HHRA.

#### **6.4.2 Overview of Laboratory Analyses**

During the RI, surface and subsurface soil samples and surface water samples were collected throughout the site, and sediment samples were collected from Otter Sluice (Exhibit 1). The soil samples were analyzed for VOC, SVOC, pesticides and PCBs, and inorganic compounds. Several soil samples were also analyzed for explosive compounds, TPH-purgeable (TPH-p), TPH-e, and hexavalent chromium. Samples collected as part of the RFA confirmation study at SWMU 37 were analyzed for VOCs, SVOCs, pesticides and PCBs, explosives, and inorganic constituents. Two composited samples were collected in the immediate area of the Wood Hogger and analyzed for dioxin compounds.

The subsurface sample collected from purposive boring WHSSB030 was also analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX) compounds.

Because dioxins were detected in the two composite samples, a more extensive sampling and analysis for dioxins was completed in 1998. Polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF) were analyzed in nine soil samples and three sediment samples collected from the Wood Hogger Terrestrial Unit near the location of the former incinerator and in sediments collected from South Otter Sluice. Exhibit 1 shows locations of samples analyzed for dioxin analysis.

Surface water samples collected at the Wood Hogger Site were analyzed for TPH, VOCs, SVOCs, pesticides and PCBs, explosive compounds, and unfiltered inorganic constituents.

#### **6.4.3 Results of Soil and Sediment Sample Analyses**

The results organic and inorganic analyses of soil and sediment samples collected at the Wood Hogger Site during the RI and at SWMU37 during the RFA confirmation study investigation (PRC 1997) were collectively used to evaluate the chemical characterization of the Wood Hogger Site described in the



sections below. The analytical results for soil and sediment samples collected during the RI at the Wood Hogger Site and the SWMU 37 investigation are presented in Appendix D, Table D-1. A statistical comparison of the collective soil and sediment analytical results and the screening criteria for the Wood Hogger Site and SWMU 37 is presented in Table 6-6.

#### **6.4.3.1 Organic Compounds in Soil**

Organic compounds including VOCs, SVOCs, pesticides and PCBs, explosive compounds, petroleum products, and dioxins were detected in soil and sediment samples collected from the Wood Hogger Site. The frequency of detection and distribution of the detected organic compounds in soil are discussed below. Exhibit 2 presents the concentrations of organic compounds detected above PRGs, along with sampling locations.

##### **VOCs**

VOCs were detected in samples collected from borings at the Wood Hogger Site. None of the VOC concentrations exceeded residential PRGs. VOCs were detected in soil samples at concentrations ranging from 20 to 720  $\mu\text{g}/\text{kg}$  and at depths between 1.5 to 20.0 feet bgs; however, except for ethylbenzene and total xylenes, the VOCs detected in the samples were either 2-butanone or acetone, which are common laboratory contaminants, or carbon disulfide, which occurs naturally in bay environments. Ethylbenzene and total xylenes were detected in the sample collected from purposive soil boring WHSSB030 (3.2 to 3.5 feet bgs) at concentrations of 160  $\mu\text{g}/\text{kg}$  and 220  $\mu\text{g}/\text{kg}$ , respectively. A black liquid with the appearance of motor oil was observed in the soil boring WHSSB030, which is located approximately 100 feet northwest of the wood hogger machinery. The liquid had a strong hydrocarbon odor; however, the PID did not measure any volatile organic vapor emanating from the liquid. Additional borings were drilled within 1 to 5 feet of boring WHSSB030. The black liquid was not found in any of these borings, so its detection is believed to be an isolated occurrence. Total xylenes were detected in two samples collected from random boring WHSSBC02 1.3 to 2.0 and 4.0 to 5.5 feet bgs at concentrations of 26 and 54  $\mu\text{g}/\text{kg}$ . No VOCs were detected in the sample collected from soil boring WHSSBC02 at depths of (8.8 to 10.0 feet bgs). No VOCs were detected in the samples collected for the SWMU37 investigation.

Soil containing detectable VOC concentrations was collected at locations scattered across the site, indicating that the presence of VOCs in site soil is not associated with disposal of wood chips at the site. No potential sources of VOCs have been identified.

## SVOCs

SVOCs, including PAHs, were detected in soil samples collected from most boreholes at the site. SVOCs were detected in surface and subsurface samples collected during the RI and SWMU37 investigation, primarily in the area of the former wood hogger machinery in the southwest portion of the site, and east of the wood hogger machinery where wood chips are believed to have been disposed of (Exhibits 1 and 2). Most samples without detectable SVOCs were collected along the north, west, and south borders of the site, where site activities were likely to have been minimal. Seven SVOCs (all PAHs) were detected in surface soil samples collected at the site at concentrations exceeding the residential PRGs. These SVOC are as follows:

- Benzo(a)pyrene was detected in nine samples at concentrations greater than the residential PRG of 56  $\mu\text{g/kg}$ . Benzo(a)pyrene was detected at concentrations up to 2,700  $\mu\text{g/kg}$ .
- Dibenzo(a,h)anthracene was detected in three samples at concentrations greater than the residential PRG of 56  $\mu\text{g/kg}$ . Dibenzo(a,h)anthracene was detected at concentrations up to 600  $\mu\text{g/kg}$ .
- Chrysene was detected in the sample collected at WHSSBC06 at a concentration of 6,400  $\mu\text{g/kg}$ , which exceeds the residential PRG of 6,100  $\mu\text{g/kg}$ .
- Benzo(b)fluoranthene was detected in four samples at concentrations greater than the residential PRG of 560  $\mu\text{g/kg}$ . Benzo(b)fluoranthene was detected at concentrations up to 3,100  $\mu\text{g/kg}$ .
- Benzo(k)fluoranthene was detected in four samples at concentrations greater than the residential PRG of 610  $\mu\text{g/kg}$ . Benzo(k)fluoranthene was detected at concentrations up to 3,400  $\mu\text{g/kg}$ .
- Benzo(a)anthracene was detected in the sample collected at WHSSBC06 at a concentration of 3,800  $\mu\text{g/kg}$ , which exceeds the residential PRG of 560  $\mu\text{g/kg}$ .
- Indeno(1,2,3-cd)pyrene was detected in the sample collected at WHSSBC06 at a concentration of 1,200  $\mu\text{g/kg}$ , which exceeds the residential PRG of 560  $\mu\text{g/kg}$ .

The highest concentrations of these PAHs were detected in the surface sample collected from soil boring WHSSBC06, which is located within the perimeter of Building A-29, north of the wood hogger machinery. The surface sample collected from WHSSBE06 also contained benzo(a)pyrene,

benzo(b)fluoranthene, benzo(k)fluoranthene, and dibenz(a,h)anthracene at concentrations greater than residential PRGs. WHSSBE06 is located 50 to 75 feet east of Building A-29. Five soil samples containing benzo(a)pyrene concentrations greater than residential PRGs were collected at locations outside of the immediate area of the wood hogger machinery. These include three locations north of the storage yard (WHSSBB05, WHSSBD03 and WHSSBF03) and two locations near the west edge of the site (WHSSB006 and WHSSBM06) (Exhibit 2). The wood preservative PCP was detected in surface samples collected from four borings in the area of the wood hogger machinery at concentrations up to 780  $\mu\text{g/kg}$ . The residential PRG for PCP is 2,500  $\mu\text{g/kg}$ . Eighteen additional SVOCs were detected in soil collected at the Wood Hogger Site at concentrations ranging from 14 to 14,000  $\mu\text{g/kg}$  and at depths between 0.0 and 20.0 feet bgs. However, concentrations were all below the respective PRGs.

Phenol was detected in three soil samples collected at part of the SWMU 37 investigation at concentrations up to 280  $\mu\text{g/kg}$ ; however, this concentration is below the residential PRG for phenol of 39,000  $\text{mg/kg}$ . No other SVOCs were detected in the samples collected during the SWMU37 investigation. All SWMU37 samples were analyzed using the CLP method.

The presence of PCP in soil collected in the area of the wood hogger is likely the result of chipping and burying wood preserved with PCP. The presence of other SVOCs in soil at concentrations exceeding PRGs may be in part or wholly the result of airborne deposition and runoff of wood smoke, or vehicle exhaust particulates, both of which are major sources of PAHs in the environment (U.S. Department of Health and Human Services 1993).

Chromatographs of samples with relatively low concentration of SVOCs showed a typical petroleum fuel pattern indicating weathered, heavier diesel. The petroleum fuels may, therefore, be the source for SVOCs in these samples. The chromatograph for the surface sample collected at WHSSBM06 did not resemble a fuel pattern; however, this sample did contain some SVOCs at low concentrations. The amount of fuel in this sample may be too low to show a typical fuel pattern.

#### **Pesticides and PCBs**

Pesticides and PCBs were detected in samples collected from most boreholes at the site. Pesticides and PCBs were detected in surface and subsurface samples collected during the RI and SWMU37 investigations. No individual pesticides, Aroclors, or PCB congeners were detected at samples at

concentrations exceeding residential PRGs and total PCBs were not detected in concentrations exceeding the residential PRG. Twenty-one Aroclors or PCB congeners were detected in surface soil samples at concentrations ranging from 0.07 to 15 mg/kg and at depths between 0.0 and 6.0 feet bgs. A total of 15 pesticides were detected at concentrations ranging from 0.1 to 280 µg/kg at depths between the surface and 6.0 feet bgs. DDT compounds were detected in most of the samples, with total DDT concentrations up to 330 µg/kg (surface sample from boring WHSSB009; Exhibit 1).

Pesticide and PCB concentrations were generally highest in the samples collected in the southern portion of the site east of the wood hogger machinery where wood chips are believed to have been disposed of (Exhibits 1 and 2), and may be the result of disposal of dunnage treated with or containing pesticides. Elevated pesticide and PCB concentrations were also detected in soil collected in the north-central portion of the site. Elevated concentrations of PCBs in this area of the site may be indicative of a source other than the wood hogging operations.

### **Explosives**

The explosive compound cyclotetramethylene tetranitramine (HMX) was detected in a soil sample from WHSSBH07 (1.3 to 2.3 feet bgs) at a concentration of 0.4 mg/kg. Borehole WHSSBH07 is located in the south-central portion of the Wood Hogger Site. The explosive compound 1,3-dinitrobenzene was detected in SWMU37 surface soil sample S37-03 at a concentration of 0.1 mg/kg. S37-03 is located approximately 50 feet north of Building A-29 in the central portion of the Wood Hogger Site. Neither HMX nor 1,3-dinitrobenzene was detected at concentrations exceeding residential PRGs of 2,700 mg/kg and 5.5 mg/kg, respectively.

### **Petroleum Hydrocarbons**

Petroleum hydrocarbons were detected in two of seven soil samples (WHSSB030, 3.2-3.5 feet bgs; and WHSSBD07, 1.5-2.3 feet bgs) (Exhibit 4). Both locations are near the wood hogger machinery in the southwest portion of the Wood Hogger Site. TPH-gasoline and TPH-motor oil were detected in both samples at concentrations up to 26 and 8,900 mg/kg, respectively, with the sample collected from soil boring WHSSB030 containing the highest concentrations. The sample collected from soil boring WHSSB030 also contained TPH-diesel at a concentration of 2,300 mg/kg. As discussed previously in this section, a black liquid resembling motor oil was observed in the soil of boring WHSSB030. Additional borings were drilled in the immediate area around soil boring WHSSB030 to define the

extent of motor oil in the soil. Visual observations and field screening indicated that motor oil was not present in soil samples from these borings; therefore, no samples from these borings were analyzed. The motor oil in the area of soil boring WHSSB030 appears to be localized. No PRGs have been established for motor oil or diesel.

## Dioxins

Two dioxins (1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin [HPCDD] and octachlorodibenzo-p-dioxin [OCDD]) and one furan (1,2,3,4,6,7,8-heptachlorodibenzo-p-furan [HPCDF]) were detected in the surface soil sample collected at WHSSB019 near the former incinerator at the Wood Hogger Site (Exhibit 1). Concentrations ranged from 0.1 to 4 µg/kg. OCDD was detected in the surface sample collected at WHSSB020, also located near the former incinerator, at a concentration of 0.4 µg/kg. Because of these detections and preliminary human health and risk evaluations, additional PCDDs and PCDFs were analyzed in soil samples from the Wood Hogger Terrestrial Unit near the location of the former incinerator and in sediments collected from South Otter Sluice. Analytical results were as follows:

Analyte	Sampling Location Concentration (µg/kg)	
	WHSSB019 (0 - 0.5 ft bgs)	WHSSB020 (0 - 0.5 feet bgs)
1,2,3,4,6,7,8-HPCDD	0.0005	ND
1,2,3,4,6,7,8-HPCDF	0.0001	ND
Total HPCDD	0.0008	ND
Total HPCDF	0.0003	ND
OCDD	0.004	0.0004

Because dioxins were detected in these two samples, a more extensive analysis was completed in 1998. The results of this study are presented below. Only 4 of 12 individual dioxins and furans were detected in any of the samples. These were, 1,2,3,4,6,7,8,9-OCDD and it's corresponding furan and 1,2,3,4,6,7,8-HPCDD and it's corresponding furan.

Sample Location	Matrix Type	Total Detected PCDD/Fs ( $\mu\text{g/kg}$ )
WHSSB008	SOIL	2
WHSSB009	SOIL	115
WHSSB010	SOIL	0
WHSSB016	SOIL	172
WHSSB109	SOIL	10
WHSSB050	SOIL	11.7
WHSSB050	SOIL	4.6
WHSSB051	SOIL	0
WHSSB051	SOIL	7
OSLSL005	SEDIMENT	0
OSLSL007	SEDIMENT	0
OSLSL008	SEDIMENT	0

The concentration of detected-only PCDDs and PCDFs shows variability in concentrations among samples. Exhibit 1 shows sampling locations and concentrations of PCDDs and PCDFs.

Dioxin and furan compounds are known to enter the environment from a variety of sources, including from use of PCP (Moore and Ramamoorthy 1984) or the combustion of wood products (Thomas and Spiro 1996). Wood dunnage believed to contain PCPs was chipped at the wood hogger and disposed of at the site. Before the wood hogger was installed, a wood incinerator was used at the site. Dioxins in soil are also ubiquitous due to fallout from numerous sources. EPA has estimated that the average soil toxicity equivalent factor (TEF) in North America is  $0.00796 \mu\text{g/kg}$  ( $\pm 0.0057 \mu\text{g/kg}$ ), which is in excess of the residential PRG for dioxin of  $0.0038 \mu\text{g/kg}$  (EPA 1994a). The estimated upper range of average soil TEF ( $0.0137 \mu\text{g/kg}$ ) in North America is greater than the TEF for the surface sample collected at WHSSB018  $0.01 \mu\text{g/kg}$ .

#### 6.4.3.2 Inorganic Chemicals in Soil and Sediment

Table 6-6 summarizes the range of metals concentrations in soil and sediment samples and the frequency that concentrations exceeded screening criteria. The metals aluminum, antimony, barium, beryllium, chromium, cobalt, copper, mercury, molybdenum, nickel, thallium, vanadium, and zinc were detected in soil and sediment collected at the site at concentrations exceeding Tidal Area estimated ambient metals concentrations, but below residential PRGs. The average concentrations of copper in

site soil are comparable to those at the Tidal Area sites, with elevated copper concentrations found mainly in the northern part of the site. The relative absence of elevated copper concentrations in the area of the wood hogger machinery indicates that the disposal of wood preserved by copper compounds (if any did occur) has not contaminated site soil. The metals arsenic, cadmium, and lead were detected in soil at the Wood Hogger Site at concentrations exceeding residential PRGs. The frequency of detection and distribution of these inorganic constituents are discussed below. Exhibit 3 presents sampling locations where concentrations of metals exceeded PRGs.

### **Arsenic**

Arsenic was detected in 117 of 128 samples collected at the Wood Hogger Site at concentrations ranging from 1.3 to 37.0 mg/kg. Although all arsenic concentrations exceeded the residential PRG of 0.38 mg/kg, only 2 of these soil samples contained arsenic at concentrations exceeding the estimated ambient concentration of 27 mg/kg. The range of arsenic concentrations detected in site soil is comparable to, and mean arsenic concentrations are less than those of other Tidal Area sites. This fact indicates that the disposal of wood preserved by arsenic compounds (if any did occur) has not contaminated site soil.

### **Cadmium**

Cadmium was detected in 37 of 128 samples obtained at the Wood Hogger Site at concentrations up to 20.8 mg/kg (WHSSBI02, surface). Eleven of the soil samples (all collected at the surface) contained cadmium at concentrations exceeding the estimated ambient concentration of 0.19 mg/kg. The surface soil samples collected from soil borings WHSSBI02, WHSSBE04, and WHSSB50 contained cadmium at concentrations exceeding the residential PRG of 9 mg/kg. The samples containing elevated cadmium concentrations were collected at locations throughout the site, though at a higher frequency in the area of the wood hogger machinery.

### **Lead**

Lead was detected in 126 of 128 samples collected at the Wood Hogger Site at concentrations ranging up to 728 mg/kg (WHSSBF03, 4.5 to 5.9 feet bgs). Sixteen soil samples (15 surface and 1 subsurface) contained lead at concentrations exceeding the estimated ambient concentration of 95 mg/kg. Thirteen soil samples (12 surface and 1 subsurface) contained lead at concentrations exceeding the residential PRG of 130 mg/kg. Most samples with elevated lead concentrations were collected at locations in the

north-central area of the site and in the area of the former wood hogger machinery. The presence of elevated lead concentrations chiefly in surface soil indicates an anthropogenic source.

#### **6.4.4 Results of Surface Water Analyses**

Surface water samples were collected as part of the RI in July and October 1995 and January and April-May 1996 from six locations at the Wood Hogger Site (Exhibit 1). Two of the sampling locations (WHSSW001 and WHSSW002) were located in Otter Sluice. Table 6-13 presents the locations sampled during each sampling event at each Tidal Area site. Surface water samples from the Wood Hogger Site were analyzed for TPH, VOCs, SVOCs, pesticides and PCBs, and explosive compounds. Surface water analytical results were screened against the PRG for tap water (Appendix I). Complete analytical results for surface water samples collected during the RI are presented in Appendix D, Table D-3. Statistical summaries of surface water analytical results for the four surface water sampling events are presented in Tables 6-16 through 6-19.

##### **6.4.4.1 Organic Compounds in Surface Water**

Xylenes were detected in one sample at a concentration of 8  $\mu\text{g/L}$ , collected in July 1996 at WHSSW006, which is less than the tap water PRG for xylenes of 1,400  $\mu\text{g/L}$ . There is no AWQC concentration for xylenes in surface water. No other organic compounds were detected in the samples.

##### **6.4.4.2 Inorganic Chemicals in Surface Water**

Surface water samples collected from the Wood Hogger Site were analyzed for unfiltered CLP inorganic compounds. Eight inorganic constituents, arsenic, cadmium, copper, iron, lead, manganese, mercury, and zinc, were detected at concentrations above the screening criteria. Cadmium, lead, and zinc were detected at concentrations exceeding the screening criteria only in samples collected from WHSSW005.

#### **6.4.5 Summary of Chemical Characterization**

The following sections summarize the chemical characterization of soil, sediment, and surface water at the Wood Hogger Site and the chemical characterization of soil at SWMU 37.



#### **6.4.5.1 Soil and Sediment**

Organic and inorganic chemicals were detected in soil and sediment samples collected at the Wood Hogger Site at concentrations exceeding residential PRGs.

##### **Organic Compounds in Soil**

SVOCs, including PAHs, were detected in soil samples collected primarily in the area of the former wood hogger machinery in the southwest portion of the site, and east of the wood hogger machinery where wood chips are believed to have been disposed of. Seven SVOCs (all PAHs) were detected in surface soil samples collected at the site at concentrations exceeding residential PRGs: benzo(a)pyrene, dibenz(a,h)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)anthracene, and indeno(1,2,3-cd)pyrene (Exhibit 2). The highest concentrations of these PAHs were detected in a surface sample collected from within the perimeter of Building A-29 and in samples from locations in the area of the wood hogger machinery. The wood preservative PCP was detected in surface samples collected from four borings in the area of the wood hogger machinery, but at concentrations less than the residential PRG. The presence of PCP in soil collected in the area of the wood hogger machinery is likely the result of site activities. The presence of other SVOCs in soil samples at concentrations exceeding PRGs may be in part or wholly the result of airborne deposition of wood smoke or vehicle exhaust particulates.

Pesticides and PCBs were detected in samples collected from the majority of boreholes at the site. No individual pesticide or PCB compounds were detected in samples at concentrations exceeding residential PRGs; however, total PCBs were detected in one sample at a concentration that exceeds the residential PRG (Exhibit 2). Pesticide and PCB concentrations were generally highest in the samples collected in the southern portion of the site east of the wood hogger machinery, where wood chips are believed to have been disposed of and may be the result of disposal of dunnage treated with or containing pesticides. Relatively elevated concentrations of PCBs in soil collected in the north-central portion of the site may be indicative of a source other than wood hogging operations.

A black liquid resembling motor oil was observed in the soil of borehole WHSSB030; however, hydrocarbons in the area of this borehole appear to be localized, based on observations of nearby conformational borings that were drilled in the immediate vicinity of boring WHSSB0303 TPH-motor

oil and TPH-diesel were detected in samples collected from boring WHSSB030 at concentrations of 8,900 mg/kg and 2,300 mg/kg, respectively. There are no established PRGs for motor oil or diesel.

Dioxins and furans were detected in one surface soil sample collected near the former incinerator at the Wood Hogger Site at an equivalent tetrachlorodibenzodioxin (TCDD) concentration of 0.01 µg/kg, which exceeds the residential PRG for TCDD. Dioxins and furans may be present at the site from disposal of wood treated with PCP, use of the former site wood incinerator, or ambient fallout. The upper range of estimated ambient fallout of dioxins in North America also exceeds the residential PRG for TCDD (EPA 1994a).

VOCs were detected in samples collected from seven borings at the Wood Hogger Site. None of the VOC concentrations exceeded residential PRGs.

No explosive compounds were detected at concentrations exceeding residential PRGs.

#### **Inorganic Chemicals in Soil and Sediment**

The inorganic constituents arsenic, cadmium, and lead were detected in soil and sediment at the Wood Hogger Site at concentrations exceeding the residential PRGs. Arsenic results generally did not exceed the estimated ambient concentration. Elevated concentrations of cadmium were also collected at locations throughout the site, with no apparent pattern of distribution. The majority of samples with relatively elevated concentrations of lead were collected at locations in the north-central area of the site, and in the area of the former wood hogger machinery. The distribution of elevated concentrations of lead indicate anthropogenic sources for these metals; however, the use or disposal of these metals at the site is not consistent with known site activities.

##### **6.4.5.2 Surface Water**

Organic and inorganic chemicals were detected in surface water samples collected at the Wood Hogger Site, with inorganic concentrations exceeding screening criteria.

#### **Organic Compounds in Surface Water**

Xylenes were detected in one surface water sample collected at the site at a concentration below the screening criteria. No other organic compounds were detected in the samples.

## **Inorganic Chemicals in Surface Water**

Arsenic concentrations and manganese exceeding screening criteria were detected in surface water samples collected at nearly all sampling locations during one or more sample events. Cadmium, copper, iron, lead, and mercury were detected at concentrations above the screening criteria in the May 1996 sample collected from WHSSW005. Zinc was detected at concentrations greater than the screening criterion in all four surface water samples collected at WHSSW005 during the RI. WHSSW005 is located northeast of SWMU 37. The presence of elevated metals concentrations primarily at this one location may indicate an anthropogenic source. Mercury was also detected at a concentration greater than the screening criterion in the May 1996 Otter Sluice surface water sample WHSSW002. With the possible exception of iron, results of WET metals tests conducted on Otter Sluice sediment indicate that the sediment concentrations have not caused metals concentration in Otter Sluice surface water samples to exceed screening criteria.

### **6.4.6 Revised Conceptual Site Model for Wood Hogger Site**

The revised conceptual site model shown on Figure 6-4 incorporates RI information into the conceptual site model for the Wood Hogger Site presented in the WP. The revised model lists potential sources, and highlights the most likely chemical migration routes. The Wood Hogger Site is bounded by Otter Sluice on the south, a levee along Otter Sluice on the west, Taylor Road on the north, and the Froid and Taylor Roads Site on the east. Although no physical evidence of chemical releases is present in the northern area, the area may receive runoff from the dunnage yard and some metal materials stored at SWMU 37. The northwestern and southern areas seasonally flood.

Site surface waters and soils in several locations are expected to be the major exposure pathways at the site. Wind transport is not considered a pathway of concern for the Wood Hogger Site. The site consists of surface water and wet, clayey soils; therefore, dust is not expected to be generated. Volatilization is not considered a pathway because of the lack of VOC detected during the RI. The RI results indicate that the Otter Sluice sediment and surface water have not been contaminated by organic chemicals from the site.

## **6.5 CHEMICAL CHARACTERIZATION OF GROUNDWATER QUALITY IN TIDAL AREA SITES**

Groundwater at the tidal area sites has been treated independently from other environmental media because the Navy and regulatory agencies agreed to review data from soils, sediments, and surface water before addressing groundwater quality issues. Based on the results presented in the draft RI in April 1997, the Navy and regulatory agencies agreed to perform a groundwater CS to address outstanding issues regarding groundwater in the Tidal Area. The groundwater CS was performed in September and October 1997, and all available information regarding groundwater at the Tidal Area sites is summarized in "Technical Memorandum: Confirmation Groundwater Sampling in the Tidal Area Sites" (TtEMI 1998b). This section presents a brief summary of groundwater quality at the Tidal Area sites, including results of the confirmation study and previous investigations. Groundwater quality in the Tidal Area sites is discussed in detail in the technical memorandum.

Currently 29 wells and 6 piezometers are in the immediate vicinity of the Tidal Area sites. Well and piezometer locations are illustrated on Figure 5-1. Twenty-three monitoring wells were installed in the Tidal Area during the site investigation 1989, six wells were installed during underground storage tank (UST) investigations in 1995, two piezometers were installed in the northern part of the R Disposal Area Site in 1995, and four piezometers were installed in the area east of the landfill in October 1997. TtEMI inspected the wells and piezometers on June 11, 1997, and verified that the wells are in good condition and comply with California monitoring well standards (California Department of Water Resources 1981, 1991). Only the 23 wells installed by IT and the two R Area Disposal Site piezometers were inspected.

In general, the monitoring wells have 10 foot well screens and the top of the screens are typically 5 to 10 feet below grade. Most of the wells are screened in a shallow unconfined water-bearing zone consisting of dark gray to black silty clay, commonly known as the Bay Mud. The Bay Mud typically exhibits low permeability, restricting movement of groundwater and causing low recharge in wells screened in the formation. In the Tidal Area sites, the Bay Mud is often described as organic-rich, or peaty, indicating a high proportion of organic material. The organic material is expected to offer abundant sites for contaminant adsorption, and is expected to significantly retard contaminant movement through the subsurface.

The wells were sampled during four separate sampling events: (1) quarterly sampling in 1990 and 1991, (2) limited confirmation sampling in 1993, (3) limited low flow-rate sampling in 1994, and (4) confirmation sampling of all wells in 1997. Analytical results from all groundwater sampling in the Tidal Area are summarized below and are presented in "Confirmation Groundwater Sampling Technical Memorandum" (TtEMI 1998b).

- **1990-1991 Quarterly Sampling:** The wells were sampled quarterly for VOCs, SVOCs, metals, pesticides and PCBs, anions, TOC, and total dissolved solids (TDS) as a part of the SI (IT 1992). Metals of potential concern, including arsenic, copper, lead, nickel, and silver, were consistently detected in monitoring wells. Organic compounds were detected intermittently at very low concentrations (near the detection limit) in a few wells, but were not detected consistently in any well.
- **1993 Limited Confirmation Study:** Selected wells were resampled in January 1993 to verify that possible data quality problems did not mask groundwater contamination by organic compounds. Groundwater samples were collected from the seven monitoring wells where VOCs and SVOCs were intermittently detected during the quarterly sampling. Organic compounds were not detected in any of the 1993 confirmation samples (James M. Montgomery, Consulting Engineers, Inc. 1993).
- **1994 Low Flow-Rate Sampling Study:** Selected wells were resampled in September 1994 using low flow rate sampling techniques. The results of the study are documented in a technical memorandum (Montgomery Watson 1994). The study proved to be inconclusive because the recharge rates in the monitoring wells were very low, and the water samples collected using the low flow-rate technique consisted primarily of stagnant water from the well casing rather than water from the formation.
- **1997 Confirmation Study:** In October 1997, all monitoring wells were sampled for metals, TDS, and total suspended solids. The seven landfill monitoring wells were also sampled for a full range of analytes (VOCs, SVOCs, metals, and pesticides and PCBs) to define analytical parameters for ongoing monitoring of the landfill. The October 1997 confirmation sampling data were consistent with the data obtained in previous investigations: metals were detected at elevated concentrations in some locations, but organic compounds were generally not detected. The comparability of the data sets from 1990 to 1991 and 1997 indicates that conditions in the subsurface are somewhat static and that metals concentrations have no long-term trend.

In summary, repeated groundwater sampling during different investigations at the Tidal Area sites has shown that metals are present at elevated concentrations in some locations, but that organic contaminants do not affect Tidal Area groundwater. The metals that are present in groundwater do not appear to form a plume of contamination emanating from the landfill. Instead, the geographic distribution of metals present in groundwater is generally characterized by isolated areas of elevated concentrations, some of which are upgradient of the landfill. Metals concentrations were generally

highest in the center of the R Area Disposal Site and the north central part of the Wood Hogger Site, but each metal present in the center of the R Area Disposal Site was also detected at relatively high concentrations in at least one of the upgradient wells along Taylor or Johnson Roads. Because the areas of elevated concentrations for different metals do not coincide, and because elevated metals concentrations were detected in groundwater at several locations upgradient and across gradient from the landfill, it is evident that the metals do not represent a plume of contamination emanating from the landfill or any other potential Tidal Area source area. Instead, the distribution of metals in Tidal Area groundwater suggests that metals are concentrated in the R Area Disposal Site by evaporative processes. Groundwater quality in the Tidal Area sites is discussed in detail in the "Confirmation Groundwater Sampling Technical Memorandum" (TtEMI 1998b). Because contamination has not been detected within the Tidal Area groundwater monitoring wells, groundwater is not considered in the human health or ecological risk assessments.

## **7.0 HUMAN HEALTH RISK ASSESSMENT**

This section presents the screening-level HHRA for the NWS SBD Concord Tidal Area sites. The objective of the HHRA was to evaluate potential risks to humans associated with exposure to contaminated media at these sites under current and possible future land-use scenarios, assuming no subsequent cleanup actions will be taken. Each of the Tidal Area sites (Site 1 - Tidal Area Landfill Site, Site 2 - R Area Disposal Site, Site 9 - Froid and Taylor Roads Site, and Site 11 - Wood Hogger Site) was evaluated separately. The HHRA is based on the site characterization and sampling data presented in Sections 1.0 through 6.0 of this report.

The media evaluated in the HHRA were soil and surface water. Potential cancer risks and noncancer health hazards associated with these media were calculated using a screening-level approach. Specifically, soil contaminant concentrations were compared with EPA Region IX PRGs (EPA 1998a). PRGs based on target cancer risks of  $1 \times 10^{-6}$  and target hazard quotients (HQ) of 1.0 were used. No PRGs are available for surface water. Because PRGs are not available to evaluate this pathway, a site-specific evaluation was conducted using standard methodology from EPA "Risk Assessment Guidance for Superfund" (EPA 1989a). Groundwater was not evaluated in the HHRA because it is not suitable for use as a drinking water source. The HHRA scope and methodology were developed in consultation with EPA and the DTSC, and were summarized in the revised HHRA approach document (PRC 1996b) for agency review. The HHRA approach is consistent with the memorandum regarding the recommended outline for using EPA Region IX PRGs in screening risk assessments at military facilities (California Environmental Protection Agency [Cal/EPA] 1994a).

This chapter is organized to reflect four basic steps of a risk assessment as follows: Section 7.1, Data Evaluation and Identification of Chemicals of Potential Concern; Section 7.2, Exposure Assessment; Section 7.3, Toxicity Assessment; Section 7.4, Risk Characterization; and Section 7.5, Summary and Conclusions. The risk characterization results for each of the NWS SBD Concord Tidal Area sites are summarized in Section 9.0 of this RI report. Section 9.0 also presents recommendations for each site evaluated in this RI.

## **7.1 DATA EVALUATION AND IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN**

This section describes the available analytical data and the approach that was used to evaluate data quality and usability for risk assessment purposes. This section also discusses the process that was used to identify COPCs, the constituents carried through the risk assessment.

### **7.1.1 Human Health Risk Assessment Data**

The available analytical data for the Tidal Area sites includes results from the SI, the RCRA investigation, CS, and the RI, as presented in Sections 4.0 through 6.0 of this report. The analytical data are presented in Appendices A through D. The media analyzed during these investigations included soil, sediment, and surface water. These studies are briefly summarized in the following subsections.

#### **7.1.1.1 Site Investigation**

The SI conducted at the Tidal Area sites from 1988 through 1992 entailed the collection of groundwater, surface water, soil, and sediment samples at all sites. Both soil and groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, TPH, explosive compounds, and metals. Results of the sampling effort were documented in the SI report (IT 1992).

#### **7.1.1.2 Solid Waste Management Unit Investigations**

In 1992, DTSC conducted a RFA at NWS SBD Concord. Investigations of SWMUs 37 and 47, which are part of Sites 11 and 2, respectively, were conducted under the RFA. Soil samples were collected at Site 11 and analyzed for VOCs, SVOCs, metals, and explosives. No soil samples were collected at Site 2. Results of these analyses are presented in Section 6.4 of the RI report.

#### **7.1.1.3 Confirmation Sampling**

Based on the results of the SI report, confirmation samples were collected at all four sites to confirm the presence and assess the extent of contamination. The results of these analyses are presented in Section 6.0 of this report.



#### **7.1.1.4 Remedial Investigation**

As part of the RI for the Tidal Area sites, soil, sediment, surface water, and groundwater samples were collected in 1995 and 1996. The samples were analyzed for SVOCs, pesticides, PCBs, and inorganics. In addition, selected samples were analyzed for the following constituents: VOCs, TPH, explosive compounds, inorganics (including hexavalent chromium), and dioxins and furans. Results of the analyses are presented in Section 6.0.

#### **7.1.1.5 Dioxin Sampling**

Two samples from Site 11 were analyzed for dioxins and furans in 1995 as part of the RI. Based on the detection of dioxins in these two samples, more extensive sampling was completed in 1998. Nine additional soil samples were collected from the Wood Hogger Terrestrial unit near the former incinerator. The locations of these samples are shown in Exhibit 1. Results of the analyses are presented in Section 6.4.3.

#### **7.1.2 Data Evaluation**

The available analytical data for the Tidal Area sites includes results from the SI, RCRA investigation, CS, and RI, as described in Section 6.0. All analytical data were reviewed to verify that data met EPA data quality criteria for use in the risk assessment.

On the basis of this review, all analytical data collected as part of the SI were considered unusable for the risk assessment. Although IT Corporation validated the data, the validation was not conducted according to EPA guidelines. A common qualifier (J) was assigned to dissimilar qualifying conditions, such as: (1) the datum was an estimate because of interference in the analytical measurement, (2) the datum value was below a quantitation limit specified by the QA/QC criteria, or (3) the datum's validity was questionable because the chemical was also found in QA/QC blanks. This "grouped" qualifier for organic constituents obscured whether the chemical was actually present in the sample or whether it was introduced as a laboratory or sampling artifact. In addition, the CS by PRC in 1992 found that most of the J-qualified analytes detected during the SI were not detected in CS samples from the same location. This suggests that much of the J-qualified data were laboratory or sampling artifacts. It should be noted that in designing the sampling plan for the RI, PRC recognized that much of the data obtained in the SI was of limited value for the RI and risk assessment.

Data validation of RI samples followed EPA data validation guidelines (EPA 1994a, 1994b), as described in the QAPP (PRC 1995). To summarize the data validation process, all RI data were subject to a cursory review, and 10 percent of the data were fully validated. The cursory review evaluated key QA/QC information such as holding times, calibration requirements, and spiking accuracy. The full validation evaluated additional QA/QC criteria and used the raw data to check calculations and analyte identifications. The overall objective of data validation was to verify that the analytical data met EPA guidelines for adequacy based on PARCC. At each stage of the validation, qualifiers were assigned to the results according to EPA guidelines (EPA 1994a, 1994b), the QAPP (PRC 1995), and the associated analytical methods.

The data validation results are documented in a QCSR presented in Appendix K of this report. The QCSR includes a discussion of the PARCC parameters, an evaluation of how well the data met the PARCC parameter goals established in the QAPP, and a summary of how meeting these PARCC goals helps achieve the DQOs for the RI. The RI data were found to meet all requirements of "definitive data" as described in "Data Quality Objectives Process for Superfund" (EPA 1993b). Definitive data are generated using rigorous analytical methods, such as approved EPA reference methods. Definitive data are also analyte-specific, with confirmation of analyte identity and concentration (EPA 1993b). All data without qualifiers and all data qualified as estimated (J) were used in the risk assessment. The data qualified as not detected (U) were also incorporated into the risk assessment by using a proxy concentration of one-half the sample quantitation limit. Only data qualified as rejected (R) were considered unusable for risk assessment purposes (EPA 1989a, 1992). General data quality issues of particular concern for the risk assessment are summarized below.

Sixty-eight percent of the hexavalent chromium data (34 out of 50 samples) were rejected. In one sample, hexavalent chromium was detected in the associated blanks and qualified as not detected (U) because the sample result was less than 5 times the blank value. However, the reporting limit specified for hexavalent chromium was below the California-modified PRG (0.2 mg/kg) (Appendix L). The following number of valid hexavalent chromium samples were collected on each site: Tidal Area Landfill (1), R Area Disposal Site (10), Froid and Taylor Roads Site (2), and Wood Hogger Site (3). Hexavalent chromium was detected in one sample at the Wood Hogger Site and no hexavalent chromium was detected at the other sites in the validated samples. However, the rejected data limits the ability to detect and distinguish hexavalent chromium from trivalent chromium, which does not represent a significant level of hazard. Based on this uncertainty, total chromium detections were

evaluated for carcinogenic risk using a EPA Region IX PRG that assumes a 1-to-6 hexavalent/trivalent chromium ratio.

Certain VOCs, SVOCs, metals, pesticides, and PCB isomers were qualified as nondetected (U) as a result of blank contamination. Further information on blank contamination is presented in Appendix K.

As part of the data evaluation process, the reporting limits (sample detection limits [DL] [for inorganic analytes] and sample quantitation limits [SQL] [for organic analytes]) were compared to soil and tap water PRGs for residential land use (EPA 1998a). For some constituents, the DL or SQL was greater than the corresponding PRG (Appendix L). In those cases, the constituents may have been present at concentrations equal to a risk greater than  $10^{-6}$  or hazard of 1, but would not have been reported. However, lower reporting limits were not generally attainable using conventional analytical techniques. For analytes for which the reporting limit exceeds the residential soil or tap water PRG, a discussion of the impact to the selection of COPCs and to the results of the HHRA is provided in Appendix L.

#### **7.1.3 Selection of Chemicals of Potential Concern in Soil**

COPCs were selected using a three-step process. First, the validated soil analytical data were assembled by site and depth interval, and a preliminary list of all analytes detected in one or more soil samples was developed for each site and depth interval. A list of all analytes detected at each site is presented in summary statistics tables in Appendix M. Second, select metals were removed from the lists on the basis of a comparison with ambient levels. Third, elements considered essential human nutrients (calcium, magnesium, potassium, and sodium) were removed from the lists.

All remaining constituents on the list for each site, except TPH, were selected as COPCs and therefore evaluated in the risk assessment. TPH evaluation is discussed in Section 7.3.2. The ambient metals screening procedures is described in greater detail below, followed by a discussion of the metals at each site that were eliminated from further consideration as soil COPCs.

##### **7.1.3.1 Comparison With Ambient Levels**

Metal concentrations in soil samples collected from each site were compared to ambient levels estimated for the NWS SBD Concord Tidal Area sites. Statistical procedures used to derive the ambient levels are described in Appendix F. Ambient levels were computed as the 99th percentile of

the ambient data set. This approach was developed in consultation with the regulatory agencies. Uncertainties associated with use of this approach in the risk assessment are discussed in Section 7.4.4.

Using the ambient levels, the selection of a particular metal as a COPC was limited to two possible outcomes, as specified below:

**All site concentrations of the metal were less than the ambient level.** The metal was considered to be unrelated to site activities and was excluded from further consideration in the risk assessment.

**Any site concentration of the metal exceeded the ambient level.** The metal was retained as a COPC.

#### **7.1.3.2 Excluded Metals for Tidal Area Sites**

The screening process led to exclusion of certain metals from further consideration in the risk assessment. Results are described on a site-by-site basis below.

<b><u>Site 1 - Tidal Area Landfill</u></b>	Barium, cobalt, manganese, and molybdenum were excluded from both the 0 to 0.5- and 0 to 10-foot depth intervals. Aluminum was also excluded from the 0 to 0.5-foot depth interval.
<b><u>Site 2 - R Area Disposal</u></b>	Cadmium was excluded from both the 0 to 0.5-foot and 0 to 10-foot depth intervals.
<b><u>Site 9 - Froid and Taylor</u></b>	Arsenic, barium, cadmium, cobalt, manganese, nickel, and thallium were excluded from both the 0 to 0.5- and 0 to 10-foot depth intervals. Molybdenum was also excluded from the 0 to 10-foot depth interval.
<b><u>Site 11 - Wood Hogger</u></b>	Manganese was excluded from both the 0 to 0.5-foot and 0 to 10-foot depth intervals. Barium and molybdenum were also excluded from the 0 to 0.5 foot depth interval.

#### **7.1.4 Identification of Chemicals of Potential Concern in Surface Water**

For surface water, all detected analytes were retained as COPCs except TPH (refer to Section 7.3.2). Although some of the detected analytes occur naturally in surface water (for example, metals), ambient levels have not been established for analytes in surface water, so no formal screening process was conducted. For Sites 2, 9, and 11, COPCs identified in surface water are also presented in Appendix M.

## **7.2 EXPOSURE ASSESSMENT**

The exposure assessment evaluates the nature and magnitude of potential exposures associated with each site. The assessment includes a description of the exposure setting and land use, the identification of potential receptors and exposure pathways, the identification of environmental media, and the estimation of exposure point concentrations.

### **7.2.1 Exposure Setting and Land Use**

The exposure setting at the NWS SBD Concord Tidal Area sites, including land use, climate, topography, geology, and hydrology is described in Section 2.0 of this report. The four Tidal Area sites are adjacent locations within a larger Tidal Area that includes diked wetlands, natural wetlands, and filled areas.

NWS SBD Concord is an open naval base and is not scheduled to close. The majority of NWS SBD Concord operations are in the Inland Area. With the exception of Site 11, activities at the Tidal Area sites are restricted to occasional grounds maintenance by base personnel and environmental restoration activities.

Infrequent and limited exposure may also occur if base personnel cross through the Tidal Area sites en route to an adjacent area. At Site 11, wood processing operations are conducted. A limited number of base support operations and storage facilities are located adjacent to the Tidal Area sites. Land use in the area around NWS SBD Concord is diverse, consisting of a mixture of military, industrial, residential, agricultural, and open space zones. There are no residential communities within the immediate vicinity of the Tidal Area. The closest residence is in the civilian community of Clyde, which is approximately 1 mile from the Tidal Area sites. The closest military residence is located more than 1 mile from the Tidal Area.

Future land use at the NWS SBD Concord Tidal Areas sites is not expected to change from its current use. Future residential, recreational, or private industrial or commercial use of the sites is therefore not anticipated. Given the current sensitivity for development in a wetland environment, it is virtually inconceivable that residential development would be permitted in the Tidal Area even if the Navy were to transfer the property to other owners. However, the residential exposure scenario is conventionally used to evaluate an unrestricted land-use exposure scenario because the residential land-use scenario represents the greatest potential for exposure to site contaminants. This unrestricted (residential) land-

use scenario generally characterizes a high potential for exposure to site contaminants. Sites found to have acceptable risk for this scenario will also have acceptable risk for other uses with lower exposure potential, such as industrial or recreational. The residential PRGs are used to evaluate this most conservative (health-protective) land-use scenario.

### **7.2.2 Potential Receptors and Exposure Pathways**

The selection of current receptors is based on land use representative of current activities at each site. For all sites, the primary receptors identified were base personnel. However, base personnel do not work on a regular basis at any of the Tidal Area sites except for SWMU 37 (Site 11). Activities at the other Tidal Area sites are restricted to occasional grounds maintenance by base personnel and environmental restoration activities. Infrequent and limited exposure may also occur if base personnel cross the site en route to an adjacent area. A limited number of base support operations and storage facilities are located in areas adjacent to the Tidal Area sites. For purposes of this risk assessment, activities of current base personnel were assumed to be similar to an industrial worker as defined by the EPA Region IX PRG document. At some sites, base visitors were also identified as potential receptors. A separate screening-level assessment of potential base visitor risks was not made because the exposure and risk estimates for an industrial worker are expected to provide an upper bound estimate of risks for a visitor. The exposure pathways evaluated for an industrial worker are consistent with the EPA Region IX PRGs and include incidental ingestion of soil, dermal contact with soil, and inhalation of airborne particulates and volatile compounds released from soil. The industrial soil PRGs (EPA 1998a) were used to assess risk associated with industrial worker exposure to COPCs detected in soil and sediment at the site.

Incidental dermal contact with surface water by base personnel was also evaluated in this HHRA. Because PRGs are not available to evaluate this pathway, a site-specific evaluation was conducted using standard methodology from EPA "Risk Assessment Guidance for Superfund" (EPA 1989a).

Potential future receptors were identified based on projected future land use and probable future activity patterns at each site. For all sites, the most probable future receptors are base personnel, however, as indicated in Section 7.2.1, a residential scenario was evaluated for each site. Potential impacts to residents were assessed for three exposure pathways: incidental ingestion of soil, dermal contact with soil, and inhalation of airborne particulates and volatile compounds released from soil. Residential exposure to COPCs in surface water at Sites 2, 9, and 11 were also evaluated.

The frequency and duration of exposure to soil COPCs assumed for each receptor used in this HHRA are specifically defined in the EPA Region IX PRGs memorandum (EPA 1998a), which is included in Appendix J. Site-specific parameters used to evaluate exposure to surface water COPCs are presented in Table 7-1. Activities performed on the NWS SBD Concord Tidal Area sites are summarized in the following subsections, primarily focusing on base personnel activities.

#### **7.2.2.1 Site 1 - Tidal Area Landfill**

The landfill is approximately 13 acres in size and contains approximately 33,000 tons of waste (IT 1992). The landfill served as a major disposal area for NWS SBD Concord from 1944 to 1979. Characterization of the nature and history of the fill in the Tidal Area Landfill was conducted during the SI phase. The contents of the landfill were sampled during prior site investigation activities and a presumptive remedy (to cap the landfill) has been proposed. This presumptive remedy would preclude the use of the actual landfill area for residential or industrial purposes and would prevent human contact with landfill materials. Therefore, a quantitative human health assessment was not performed for the landfill refuse or within the landfill footprint.

During the RI, surface and subsurface soil sampling was conducted around the perimeter of the landfill to assess whether chemicals may be migrating from the landfill. The risk assessment was based on the results of those samples. There are ordinarily no base personnel at the Tidal Area Landfill Site. However, infrequent and short-duration visits to the site may be made by personnel involved in occasional grounds maintenance activities.

#### **7.2.2.2 Site 2 - R Area Disposal Site**

Portions of the R Area Disposal Site were used for the disposal of materials generated during the segregation of conventional munitions returned from Pacific operations (E&E 1983). There are normally no personnel on the site. However, base personnel routinely work in the vicinity of the segregation complex which is located on the perimeter of the R Area Disposal Site. Although there is a natural boundary that separates the segregation complex and the disposal area, it is conservatively assumed that base personnel may occasionally visit the disposal area site. Most of the R Area Disposal Site is seasonally flooded, so access to the site is further restricted.

#### **7.2.2.3 Site 9 - Froid and Taylor Roads Site**

Minor disposal activity has been reported at the Froid and Taylor Roads Site. The northern portion of the site contains a small central area that appears to be perennially flooded, which could represent surfacing groundwater. There are typically no personnel on the site. However, base personnel routinely work in the railroad personnel office which is located across the road from the site.

#### **7.2.2.4 Site 11 - Wood Hogger Site**

A wood disposal area is located on the Wood Hogger Site (E&E 1983). An incinerator also operated on the site from approximately 1969 to 1973 (PRC and Montgomery Watson 1994a, 1994b, 1994c). Undeveloped areas to the north and south of a storage yard were included in the site. Flooding occurs in the northern area of the site and standing shallow water (potentially surfacing groundwater) has been observed in the southern portion of the site along the levee.

### **7.2.3 Environmental Media**

The environmental media evaluated in the NWS SBD Concord Tidal Area HHRA include soil and surface water. Strategies for addressing risks associated with exposure to these two media and groundwater, fish, and produce are presented in the following sections.

#### **7.2.3.1 Soil**

For all sites (Sites 1, 2, 9, and 11) evaluated in this HHRA, the primary medium of concern was soil. The risks associated with industrial and residential land use were evaluated using analytical data obtained from both surface soil (0 to 0.5 feet bgs) and subsurface soil (0 to 10 feet bgs). Industrial and residential exposures to surface soil contaminants were evaluated assuming that the site configuration will remain unchanged in the future. In addition, because construction activities required to develop residential housing or industrial facilities at the site in the future would likely disturb existing site conditions, industrial and residential exposures to contaminants in subsurface soil was also evaluated. It is assumed that all existing structures, buildings, and paved surfaces might be removed during these construction activities. Based on DTSC guidance, it is also assumed that soil mixing may occur to a depth of 10 feet during such construction activities.



#### **7.2.3.2 Surface Water**

The surface water bodies surrounding the Tidal Area sites (Suisun Bay, Hastings Slough, and Belloma Slough) are not accessible for swimming and wading and were not sampled during RI activities. The Tidal area surface water samples were collected in Otter Sluice and from standing or ponding water at Sites 2, 9, and 11. Access to Otter Sluice by base personnel is restricted by fence located around the perimeter of the sluice and tide gate. Based on these access restrictions and because Otter Sluice is a shallow body of water (3 feet), it is assumed that Otter Sluice is not currently suitable for swimming. Standing or ponding water is generally present on Sites 2, 9, and 11 during the rainy season only. Consequently, exposure to that surface water is limited to the wet months (October through March) and is not generally possible during the remainder of the year (that is, the dry season).

Although considered unlikely, it was conservatively assumed that an individual may occasionally be exposed to contaminants in Otter Sluice and standing water during grounds maintenance activities conducted by base personnel or recreational activities conducted by residents in the Tidal Area sites. It is further assumed that exposure would be restricted to limited wading because these surface water bodies are too shallow for complete submersion in the water (that is, swimming). The exposure parameters used to evaluate potential contact with surface water were selected based on these site conditions and assume limited wading or incidental contact with surface water. It was assumed that an adult and child would be exposed to surface water 2 hours per exposure event. One exposure event per week, or 52 events per year, was also assumed. Site-specific parameters used to evaluate exposure to surface water COPCs are presented in Table 7-1. The remaining exposure factors are from the EPA PRG memorandum (EPA 1998a). Because no surface water PRGs are available, risks were characterized based on incidental dermal exposure to surface water as described further in Section 7.4.1.4.

#### **7.2.3.3 Groundwater**

Groundwater from the shallow Bay Mud aquifer that underlies the Tidal Area is not suitable for use as a drinking water source, based on low hydraulic conductivity of the aquifer, and high TDS, hardness, chlorides, and iron concentrations in the water (IT 1992). Groundwater samples from additional wells were not collected during the RI because results of prior investigation activities did not indicate that contaminants were present in groundwater. However, groundwater samples were collected from existing monitoring wells to evaluate the area for evidence of groundwater contamination. No evidence

of groundwater contamination was found, therefore the groundwater pathway was not evaluated in this HHRA.

Most private and city municipal water in the region is supplied by treated surface water sources, although some wells in the vicinity of the NWS SBD Concord Inland Area are used for water supply, including several wells in the industrial complex area to the west of NWS SBD Concord, which are used primarily for process water and cooling water. Groundwater from a series of potable water wells surrounding Mallard Reservoir, also located west of NWS SBD Concord, is used to augment aqueduct supplies of drinking water to the reservoir during droughts; however, IT reports that these wells have been used only three times since the mid-1960s. These wells are not downgradient of the Tidal Area sites and therefore would not be affected by NWS SBD Concord activities. Groundwater flows northward toward Suisun Bay. Suisun Bay provides important habitats for aquatic life and supports a number of uses including recreation, fishing, and shipping.

#### **7.2.3.4 Fish**

Because of the access restrictions to the Tidal Area sites and the fact that it is also very difficult to access the Bay from the Tidal Area sites, fish have not historically been caught and eaten by military personnel at NWS SBD Concord. Fishing is also not anticipated to be a future activity at the site. In addition, fish caught in the Bay are typically migratory and do not live and feed exclusively in one area, so contaminants detected in fish tissues would be difficult to link to a discrete source or the Tidal Area sites.

Further, in a RWQCB study, it is documented that ingesting fish caught in the Bay can result in adverse health effects. Although no signs prohibiting fishing are posted at the Tidal Areas, the Office of Environmental Health Hazard Assessment of the Cal/EPA has published health advisories warning that high levels of contaminants may be present in fish in San Francisco Bay (Cal/EPA 1994b). In view of these factors, fish ingestion is assumed to pose a health risk, but one that can not be readily related to activities at the Tidal Areas; therefore, consumption of fish is not evaluated in this risk assessment.

#### **7.2.3.5 Produce**

Since no produce is currently grown at NWS SBD Concord, it was not possible to directly assess the potential for human health risk associated with ingestion of produce grown on the Tidal Area sites. To estimate concentrations of contaminants that could occur in homegrown produce, modeling techniques

are typically employed; however, the uncertainties associated with the use of default input parameters and assumptions in such models are high.

In addition, because NWS SBD Concord is an open naval base, current activities at the site are limited to industrial operations and maintenance activities performed by base personnel. Residential exposure to contaminants in homegrown produce is very unlikely under these land-use conditions and was not evaluated quantitatively.

#### **7.2.4 Exposure Point Concentrations**

For each site in the NWS SBD Concord Tidal Areas, soil COPC concentrations (referred to as exposure point concentrations) were estimated for use in the quantitative risk analysis. Exposure point concentrations were also estimated for surface water at Sites 2, 9, and 11. For both soil and surface water, exposure point concentrations were estimated using analytical data obtained during RCRA investigations, RI, and confirmation sampling efforts. Uncertainties associated with the exposure point concentrations estimation methods are discussed in Section 7.4.4.

In consultation with DTSC and EPA, the use of the upper 95 percent upper confidence limit on the arithmetic mean (95th UCL) as the exposure point concentration for each COPC was selected as a reasonable approach for the Tidal Area sites, provided that the number of samples collected at each site was adequate to characterize the nature and extent of chemical contamination. Also, because both purposive and random sampling approaches were applied in the RI to characterize areas that were most likely to be contaminated (based on SI sample results) and to define the extent of contamination in the RI source areas, it is unlikely that areas of significant contamination were not sampled during investigation efforts.

The use of 95th UCL concentrations is recommended by EPA (EPA 1992) for evaluating reasonable maximum exposure (RME) conditions at a site and is consistent with DTSC and EPA guidance for baseline HHRAs. EPA defines RME as the highest exposure that is reasonably expected to occur at a site (EPA 1989a). Typically, DTSC indicates that the maximum concentration of each contaminant should be used as the exposure point concentration for comparisons against PRGs for screening-level risk assessments (Cal/EPA 1994a). This policy is based on the assumption that few samples would be available for evaluation in a screening-level risk assessment. DTSC indicated that the size of the samples collected at each of the Tidal Area sites were large enough to adequately characterize the site.

Consequently, the 95th UCL is used as the exposure point concentration for each COPC, with some exceptions. For small data sets, the 95th UCL often exceeded the maximum detected concentration at a site because the standard deviation associated with small data sets is high. In these instances, the maximum detected concentration was used as the exposure point concentration (EPC). In addition, for purposes of comparison, the cancer risk estimates and hazard indices that result from the use of maximum concentrations as exposure point concentrations are also presented in Appendix M.

The methods used to calculate exposure point concentration estimates are presented in Appendix M. The statistical summaries for all analytes detected are also presented in Appendix M. The statistical summaries present the maximum, minimum, average, and 95th UCL concentrations of all analytes detected in soil and surface water. For soil, exposure point concentrations were estimated for "surface soils" (0 to 0.5 feet bgs) and "subsurface soils" (0 to 10 feet bgs). All surface water data obtained at Sites 2, 9, and 11 were used to calculate the exposure point concentrations used in this HHRA to evaluate potential exposure to these media.

### **7.3 TOXICITY ASSESSMENT**

A toxicity assessment typically includes two components: (1) brief descriptions of the major toxicological effects associated with the chemicals of concern identified at a site (toxicity profiles) and (2) a list of toxicity values (slope factors [SF] and reference doses [RfD]) used in the risk assessment for characterization of risk and hazards. Toxicity profiles for chemicals which exceed PRGs or have a HQ greater than 1, are presented in Appendix I.

Toxicity values developed by EPA (EPA 1998a, 1998b) are used to derive PRGs, and these values are listed in the EPA memorandum regarding the derivation of the Region IX PRGs, presented in Appendix J. Section 7.3.1 describes the source of specific toxicity values used to calculate the PRGs selected for use in this risk assessment, and Section 7.3.2 identifies surrogate PRGs used for chemicals for which PRGs are not available because toxicity values have not been developed by EPA.

Uncertainties associated with the toxicity assessment are discussed in Section 7.4.4.

#### **7.3.1 Toxicity Values**

PRGs are health-based concentrations for individual chemicals that are calculated using published toxicity values. PRGs correspond to a risk of  $1 \times 10^{-6}$  or a noncarcinogenic HQ of 1. In most cases, when exposure to a specific chemical has been associated with both cancer and noncancer effects, only

the more stringent value (typically, the value corresponding to a cancer risk of  $1 \times 10^{-6}$ ) is presented in the printed PRG table. The electronic version of the EPA Region IX PRGs includes PRGs corresponding to the noncancer effects of carcinogens (available at <http://www.epa.gov/region09/waste/sfund/prg/index.html>). Both the cancer risk and noncancer effect-based PRGs were used, when available. Table 7-2 presents all the PRGs used to evaluate the Tidal Area sites.

EPA Region IX PRG tables include California-modified PRGs for cadmium, hexavalent chromium, nickel, benzo(a)pyrene, benzo(k)fluoranthene, and chrysene (EPA 1998a). The California-modified PRGs were used in place of their EPA Region IX PRGs.

For evaluation of the dermal contact with surface water scenario, cancer slope factors and noncancer reference doses were obtained from the EPA Region IX PRG memorandum (EPA 1998a).

To evaluate the cancer risk from polychlorinated dibenzodioxins (dioxins) and polychlorinated dibenzofurans (furans), the dioxin and furan concentrations were converted to 2,3,7,8-TCDD toxicity equivalents (TEQ). TCDD is considered the most potent congener of the PCDDs and PCDFs. EPA developed a TEF scheme (EPA 1989b) to estimate the toxicity of dioxins and furans relative to the toxicity of TCDD. The TEF for 2,3,7,8-TCDD is defined as unity (1); TEFs for the other dioxins and furans are less, accounting for their lower potency. A 2,3,7,8-TCDD TEQ is calculated for each individual dioxin or furan congener by multiplying its concentration by its corresponding TEF. For a laboratory analysis reported as not detected, half the SQL was substituted as a proxy concentration. The sample TEQ is the sum of the TEQs for all congeners detected in that sample.

As described in Section 7.1.2, total chromium detections were evaluated for cancer risk using the EPA Region IX PRG that assumes a 1-to-6 hexavalent/trivalent chromium ratio. The hexavalent chromium detected at Site 11 in one sample was evaluated using the California-modified PRG for hexavalent chromium. Uncertainties associated with chromium speciation are further discussed in Section 7.4.4.3.

### **7.3.2 Chemicals With No Toxicity Values**

The Region IX PRGs use route-to-route extrapolation when no route-specific toxicity values are available. Oral RfDs and SFs are used to derive PRGs when dermal or inhalation toxicity values are not available (EPA 1998a). In addition, inhalation toxicity factors are used to evaluate oral exposure when no oral toxicity values were available.

The following chemicals were detected at the Tidal Area sites but do not have toxicity values: 1-methylnaphthalene, 1-methylphenanthrene, 2,6-dimethylnaphthalene, 2-methylnaphthalene, acenaphthylene, benzo(e)pyrene, benzo(g,h,i)perylene, perylene, phenanthrene, alpha-chlordane, gamma-chlordane, technical chlordane, endrin ketone, trans-nonachlor and certain inorganic compounds. The naphthalene RfD was used as a surrogate for 1-methylnaphthalene, 1-methylphenanthrene, 2,6-dimethylnaphthalene, 2-methylnaphthalene, perylene, and phenanthrene. The acenaphthene RfD was used as a surrogate for acenaphthylene. The pyrene RfD was used as a surrogate for benzo(e)pyrene and benzo(g,h,i)perylene. The endrin RfD was used as a surrogate for endrin ketone. The chlordane slope factor and RfD was used to evaluate alpha-chlordane, gamma-chlordane, technical chlordane, and trans-nonachlor. These surrogate toxicity values were used to derive PRGs using the EPA Region IX PRG equations presented in Appendix J. Table 7-2 presents the PRGs used to evaluate the Tidal Area sites.

In addition, there are currently no accepted toxicity values for TPH; however, Cal/EPA has adopted a constituent-based approach for evaluating the toxicity of petroleum hydrocarbon mixtures (Cal/EPA 1993). This approach involves evaluating the more toxic constituents of TPH, such as BTEX and PAHs. Toxicity values exist for these constituents. Where these constituents were detected, they were quantitatively evaluated.

## **7.4 RISK CHARACTERIZATION**

In this section, potential impacts to human health from COPCs are characterized for each NWS SBD Concord Tidal Area site using industrial and residential exposure scenarios. Section 7.4.1 presents the methods used to estimate cancer risks and noncancer health hazards associated with exposure to COPCs in soil and surface water at the Tidal Area sites, as well as health effects from exposure to lead. Section 7.4.2 presents the risk and hazard estimates for each of the Tidal Area sites. In Section 7.4.3, COPC concentrations are compared to soil screening levels. Uncertainties associated with the risk assessment are discussed in Section 7.4.4.

### **7.4.1 Risk Characterization Methodology**

For the NWS SBD Concord Tidal Area sites, cancer risks and hazard indices for noncancer health effects are estimated by comparing site concentrations of each COPC to EPA Region IX industrial and residential PRGs (EPA 1998a).

#### 7.4.1.1 Cancer Risks

PRGs are typically used as a screening tool to assess the potential threat to human health associated with exposure to a single contaminant in a particular environmental medium. For COPCs that are classified as carcinogens, cancer risk associated with exposure to a single contaminant is estimated by comparing the exposure point concentration of the carcinogen (95th UCL) to the cancer risk-based PRG using the following equation:

$$\text{Cancer risk} = (\text{EPC}/\text{PRG}) \times 10^{-6}$$

where:

EPC	=	Exposure point concentration (mg/kg)
PRG	=	EPA Region IX preliminary remediation goal (mg/kg)

At a given site, individuals may be exposed to more than one substance. The cancer risks associated with exposure to multiple contaminants can be assessed using an approach outlined by EPA in its memorandum regarding the derivation of PRGs (EPA 1998a). The total risk from exposure to multiple contaminants is calculated using the following equation:

$$\text{Total risk} = 10^{-6} \times \{ \text{EPC}_1/\text{PRG}_1 + \text{EPC}_2/\text{PRG}_2 + \dots \text{EPC}_n/\text{PRG}_n \}$$

where:

Total risk	=	Total carcinogenic risk from exposure to all contaminants (unitless)
$\text{EPC}_n$	=	Exposure point concentration of contaminant n (mg/kg)
$\text{PRG}_n$	=	PRG for contaminant n (mg/kg)

Cancer risk is expressed as a probability. For example,  $10^{-6}$  translates to an individual excess cancer risk of 1 in 1 million. The NCP indicates "that for known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual between  $10^{-4}$  and  $10^{-6}$ " (EPA 1990b). Risks that fall within this range are said to be within the acceptable risk range, and risks below  $1 \times 10^{-6}$  are considered insignificant. Risks above  $10^{-4}$  exceed the acceptable risk range and may indicate the need for further evaluation or remediation. For the purposes of this assessment, the range between  $1 \times 10^{-4}$  and  $1 \times 10^{-6}$  is referred to as the target risk range.

#### 7.4.1.2 Noncancer Health Hazards

For COPCs that are not classified as carcinogens and for those carcinogens with PRGs based on health effects other than cancer, the potential for individuals to develop adverse health effects is evaluated by comparing exposure point concentrations (95th UCL) to noncancer risk-based PRGs. When calculated for a single chemical, this comparison produces a HQ and is expressed in the following equation:

$$\text{Hazard quotient} = \text{EPC/PRG}$$

where:

PRG = EPA Region IX preliminary remediation goal (mg/kg)  
EPC = Exposure point concentration (mg/kg)

To evaluate the potential for noncancer health effects from exposure to multiple chemicals, the HQs for all chemicals are summed, yielding a hazard index as follows:

$$\text{Hazard index} = \text{EPC}_1/\text{PRG}_1 + \text{EPC}_2/\text{PRG}_2 + \dots + \text{EPC}_n/\text{PRG}_n$$

where:

$\text{EPC}_n$  = Exposure point concentration of contaminant n (mg/kg)  
 $\text{PRG}_n$  = PRG for contaminant n (mg/kg)

Total hazard indices of 1 or less indicate that there is no appreciable risk of adverse noncancer health effects (EPA 1998a). When the total hazard index exceeds 1, further evaluation in the form of a segregation of hazard index analysis is typically performed to evaluate whether or not noncarcinogenic hazards are a concern at the site. This is because the noncancer effects of chemicals with different target organs are generally not additive. The approach used was to group the COPCs according to the target organ affected by each COPC at the lowest-adverse-effect levels (that is, the critical effects) identified by EPA. If any one segregated hazard index exceeds 1, it indicates the potential for adverse noncancer health effects to occur (EPA 1989a). A segregated hazard index of less than 1 indicates that there is no appreciable risk of adverse noncarcinogenic health effects. The critical effects of noncarcinogenic COPCs are presented in Table 7-3.



#### **7.4.1.3 Lead Evaluation**

The PRG for lead does not represent a soil concentration corresponding to a HQ of 1. Instead, the California-modified residential soil PRG for lead was calculated using the Cal/EPA blood-lead model, which is used to estimate blood-lead concentrations that may result from exposures to both site-related and nonsite-related lead sources. Based on the model, a blood-lead concentration of 10 micrograms per deciliter ( $\mu\text{g/dL}$ ) corresponds to a lead soil concentration of 130 mg/kg for a child resident. The EPA Region IX residential and industrial soil PRGs for lead are 400 mg/kg and 1,000 mg/kg, respectively. For the purposes of this assessment, lead is evaluated separately by comparing site soil concentrations to the lead PRGs. Site concentrations in surface water are compared to the residential tap water PRG for lead ( $4 \mu\text{g/L}$ ). This is a very conservative comparison given that use of the tap water PRGs assumes greater exposure (via ingestion) than exposure anticipated at the Tidal Area sites (via incidental dermal contact with surface water). Because lead is evaluated separately using PRGs rather than by calculating a HQ, lead is excluded from the tables in Appendix M.

#### **7.4.1.4 Iron Evaluation**

EPA recently established a PRG for iron based on the provisional oral RfD established by National Center for Environmental Assessment (NCEA) (1999). The RfD represents a level that is both sufficient to protect against iron deficiency and insufficient to cause the toxic effects of iron overload. The RfD was derived using the upperbound value (0.27 mg/kg per day [mg/kg/day]) in the range of average dietary intakes (0.15 to 0.27 mg/kg/day) from a National Health and Nutrition Examination Survey database. In this survey, biochemical indices of iron status (that is, serum ferritin levels) were used to confirm that blood iron levels remained within a normal range when dietary intakes of iron were within the range of 0.15 to 0.27 mg/kg/day. It should be noted that the "Risk Assessment Issue Paper for Derivation of a Provisional RfD for Iron" (NCEA 1999) has not been through the formal EPA review process.

A qualitative assessment of risks associated with iron concentrations at the Tidal Area sites is conducted because the average and maximum detected soil iron concentrations exceed the EPA residential soil PRG of 22,000 mg/kg for all four of the Tidal Area sites. This assessment of soil iron concentrations is based on the following considerations:

- The range of average soil iron concentrations for the four Tidal Area sites of 19,100 to 32,300 mg/kg is well within the range of background California soil iron concentrations of 10,000 to 87,000 mg/kg (Bradford and others 1996).
- The 99th percentile ambient value for iron at the Tidal Area sites is 90,000 mg/kg.
- The iron ambient value established for the Tidal Area sites was exceeded in only one soil sample at the four Tidal Area sites.
- Adverse health effects associated with California background soil iron concentrations have not been reported.
- Iron is an essential nutrient.
- The recommended dietary allowance (RDA) of iron is 10 mg/day for children over the age of 1 year and adult males and 15 mg/kg for adult females.
- The RDA does not represent a maximum safe dose, but a minimum requirement for proper nutrition, and is routinely supplied in vitamin supplements.

Based on these considerations, the health risks associated with iron in soil at the Tidal Areas are very low. Consequently, iron is not evaluated quantitatively in this HHRA.

#### **7.4.1.5 Surface Water Evaluation**

No surface water PRGs are available to evaluate surface water risks and hazards. Therefore, risks associated with potential exposure to COPCs identified in surface water were evaluated using methods consistent with EPA guidance provided in "Risk Assessment Guidance for Superfund, Part A" (EPA 1989a). The specific equation and exposure parameters used for this evaluation are presented in Table 7-1. To be consistent with the Region IX PRGs, cancer risks were evaluated for adults and children combined, while noncancer risks were evaluated for children only. Surface water-related cancer risks and noncancer health hazards are discussed in Section 7.4.2.

#### **7.4.2 Risk and Hazard Estimates**

Cancer risks and noncancer health hazards associated with industrial and hypothetical future residential land-use conditions for each of the Tidal Area sites are summarized in the following section.

Chemical-specific and total cancer risks and noncancer health hazards for each land-use scenario, soil depth, and environmental medium are presented in Appendix M. Risks and hazards are discussed for both the surface soil (0 to 0.5 feet bgs) and subsurface soil (0 to 10 feet bgs) data sets; risk and hazard totals for both residential and industrial worker land-use scenarios are presented in site-specific tables.

Cancer risks and hazard indices were estimated using both RME and maximum detected media concentrations; however, only the risk characterization results of the RME case are discussed unless otherwise stated.

#### **7.4.2.1 Site 1 - Tidal Area Landfill**

The objective of the HHRA conducted in the R Area in the immediate vicinity of Site 1 (Tidal Area Landfill) was to evaluate the potential cancer risks and noncancer health hazards associated with COPCs in surface soil (0 to 0.5 feet bgs) and subsurface soil (0 to 10 feet bgs) at the site. The risk characterization results for Site 1 are summarized in Tables 7-4 (industrial scenario) and 7-5 (residential scenario). Tables M-12 through M-17 in Appendix M present the chemical-specific and multichemical total cancer risk estimates and hazard indices for industrial and residential exposure scenarios and all the site COPCs.

**Soil – Industrial Scenario:** The RME cancer risk estimates for an industrial worker scenario based on exposure to COPCs identified in surface soil ( $1.2 \times 10^{-5}$ ) and subsurface soil ( $6.8 \times 10^{-6}$ ) at Site 1 are within the target risk range. Arsenic was the only carcinogenic constituent identified for the industrial land-use scenario at Site 1 for which the cancer risk estimate ( $1.1 \times 10^{-5}$ ) exceeded  $1 \times 10^{-6}$ . The arsenic detected in soil does not appear to be site related; no source of arsenic has been identified and site concentrations are comparable to ambient levels. The cancer risk estimate associated with industrial exposure to ambient levels of arsenic is  $9.0 \times 10^{-6}$  (Table 7-12).

The total hazard indices for the industrial exposure scenario based on surface and subsurface soil are less than 1, indicating no appreciable risk of adverse noncancer health effects for an individual working in the vicinity of the Site 1 Tidal Area Landfill.

**Soil – Residential Scenario:** The RME cancer risks for resident exposure scenarios for surface soil ( $9.2 \times 10^{-5}$ ) and subsurface soil ( $5.4 \times 10^{-5}$ ) at Site 1 are within the target risk range. The risks for both soil depth intervals can be attributed primarily to arsenic and benzo(a)pyrene. Benzo(a)pyrene was detected in only 1 of 23 samples at a concentration (0.07 mg/kg) comparable to background levels of PAHs in urban and rural soils. Background concentrations of benzo(a)pyrene range from 0.165 to 0.22 mg/kg in urban soils and 0.002 to 1.3 mg/kg in rural soils (Agency for Toxic Substances and Disease Registry [ATSDR] 1995).

The total hazard index for residential exposure scenarios for surface soil (2.1) is greater than 1. This hazard can be attributed primarily to the HQ for arsenic (1.61). The total hazard index for subsurface soil is 1.7, with a maximum segregated hazard index for 1.09 for skin effects. The hazard index can be attributed primarily to arsenic. The HQ for residential exposure to ambient levels of arsenic is 1.29 (Table 7-13).

**Lead Evaluation:** The RME lead concentrations in surface soil (108 mg/kg) and subsurface soil (56.7 mg/kg) are below the California-modified residential PRG (130 mg/kg) and the EPA Region IX industrial PRG of 1,000 mg/kg.

#### **7.4.2.2 Site 2 - R Area Disposal**

The objective of the HHRA conducted at Site 2 (R Area Disposal) was to evaluate the potential cancer risks and noncancer health hazards associated with COPCs in surface soil (0 to 0.5 feet bgs), subsurface soil (0 to 10 feet bgs), sediment, and surface water at the site. The risk characterization results for Site 2 are summarized in Tables 7-6 (industrial scenario) and 7-7 (residential scenario). Tables M-18 through M-29 in Appendix M present the chemical-specific and multichemical total cancer risk and hazard indices for industrial and residential exposure scenarios and all site COPCs.

**Soil – Industrial Scenario:** The RME cancer risk estimates for an industrial worker exposure scenario based on COPCs in surface soil ( $5.3 \times 10^{-6}$ ) and subsurface soil ( $5.8 \times 10^{-6}$ ) at Site 2 are within the target risk range. Arsenic was the only carcinogenic constituent for which the associated cancer risk estimate exceeds  $1 \times 10^{-6}$  for industrial land use at Site 2. The arsenic detected in soil does not appear to be site related; no source of arsenic has been identified and site concentrations are comparable to ambient levels.

The hazard indices for industrial exposure to COPCs in surface soil and subsurface soil are less than 1, indicating no appreciable risk of adverse noncancer health effects for workers at Site 2.

**Soil – Residential Scenario:** The RME cancer risk estimates for resident exposure scenarios based on surface soil ( $4.1 \times 10^{-5}$ ) and subsurface soil ( $4.4 \times 10^{-5}$ ) are within the target risk range. For both depth intervals, the risks at the site can be attributed to arsenic, benzo(a)pyrene, and dibenz(a,h)anthracene. Arsenic-related cancer risk estimates exceeded a risk of  $1 \times 10^{-6}$  with risk estimates of  $3.6 \times 10^{-5}$  and  $3.7 \times 10^{-5}$ , respectively, for surface and subsurface soil. No source of arsenic has been identified for the site, and ambient arsenic concentrations present similar risks (that is,

$7.1 \times 10^{-5}$ ). The risks associated with benzo(a)pyrene and dibenz(a,h)anthracene are based on surface soil RME concentrations of 0.1 mg/kg and 0.09 mg/kg, respectively, which are comparable to background PAH levels in urban and rural soils (ATSDR 1995).

For residential exposure scenarios based on COPCs in surface and subsurface soil, the total hazard indices are 1.46 and 1.47, respectively. While the total hazard indices are greater than the threshold value of 1, the results of the segregation of hazard indices do not exceed 1 for any toxicological endpoint, indicating no appreciable risk of adverse noncarcinogenic health effects (Tables M-22 and M-23).

**Surface Water – Industrial Scenario:** The RME cancer risk estimate for incidental dermal exposure using an industrial exposure scenario for COPCs in surface water ( $1.7 \times 10^{-7}$ ) is below the target risk range and the corresponding hazard index is less than 1 indicating no appreciable risk of adverse noncarcinogenic health effects.

**Surface Water – Residential Scenario:** The RME cancer risk estimate for incidental dermal exposure using a residential exposure scenario for COPCs in surface water ( $2.6 \times 10^{-7}$ ) is below the target risk range and the corresponding hazard index is less than 1 indicating no appreciable risk of adverse noncarcinogenic health effects.

**Lead Evaluation:** The RME lead concentrations in surface soil (77.7 mg/kg), subsurface soil (77.7 mg/kg), and sediment (89.5 mg/kg) are below the California-modified residential PRG (130 mg/kg) and the EPA Region IX industrial PRG of 1,000 mg/kg. For surface water, the lead concentration (2.8 µg/L) is below the tap water PRG of 4 µg/L.

#### **7.4.2.3 Site 9 - Froid and Taylor Roads**

The objective of the HHRA conducted at Site 9 (Froid and Taylor Roads) was to evaluate the potential cancer risks and noncancer health hazards associated with COPCs in surface soil (0 to 0.5 feet bgs), subsurface soil (0 to 10 feet bgs), and surface water at the site. The risk characterization results for Site 9 are summarized in Tables 7-8 (industrial scenario) and 7-9 (residential scenario). Tables M-30 through M-39 in Appendix M present the chemical-specific and multichemical total risks and hazard indices for industrial and residential exposure scenarios and all site COPCs.

**Soil – Industrial Scenario:** The RME cancer risk for an industrial worker scenario based on exposure to COPCs in surface soil ( $5.6 \times 10^{-7}$ ) and subsurface soil ( $5.5 \times 10^{-7}$ ) are below the target risk range, and the hazard indices are less than the threshold value of 1 indicating no appreciable risk of adverse noncarcinogenic health effects.

**Soil – Residential Scenario:** The RME cancer risk estimates for a residential exposure scenario based on COPCs in surface soil ( $3.2 \times 10^{-6}$ ) and subsurface soil ( $3.2 \times 10^{-6}$ ) are within the target risk range. Benzo(a)pyrene was the only constituent identified for which the cancer risk estimate exceeded a risk of  $1 \times 10^{-6}$  for a residential land-use scenario at Site 9; surface soil and subsurface soil risk estimates were both  $2 \times 10^{-6}$ . The risks associated with benzo(a)pyrene are based on the maximum detected concentration of 0.1 mg/kg, which is comparable to ambient benzo(a)pyrene levels in urban and rural soils (ATSDR 1995). Benzo(a)pyrene was detected in 2 of 17 samples collected at Site 9.

The RME hazard indices for surface soil (0.43) and subsurface soil (0.41) are below the threshold value of 1 indicating no appreciable risk of adverse noncarcinogenic health effects.

**Surface Water – Industrial Scenario:** The RME cancer risk estimate for incidental dermal exposure for an industrial exposure scenario is  $3.5 \times 10^{-6}$ . Arsenic is the only carcinogenic constituent for which the cancer risk estimate exceeded  $1 \times 10^{-6}$ . The risk estimate for arsenic is based on the RME and the maximum detected concentration of 0.28 milligrams per liter (mg/L). The RME hazard index is less than the threshold value of 1 indicating no appreciable risk of adverse noncarcinogenic health effects.

**Surface Water – Residential Scenario:** The RME cancer risk estimate for incidental dermal contact for a residential exposure scenario ( $5.3 \times 10^{-6}$ ) is within the target risk range. Arsenic is the only carcinogenic constituent for which the cancer risk estimate exceeded  $1 \times 10^{-6}$ . The RME hazard index is less than the threshold value of 1 indicating no appreciable risk of adverse noncarcinogenic health effects.

**Lead Evaluation:** The RME lead concentrations in surface soil (515 mg/kg) and subsurface soil (319 mg/kg) are below the industrial PRGs of 1,000 mg/kg. Lead concentrations in surface soil exceed the EPA Region IX residential PRG of 400 mg/kg. The RME lead concentration in surface soil is equal to the maximum detected concentration of 515 mg/kg, and only one of the surface soil samples exceeded the residential PRG. For surface water, the lead concentration (2.0 µg/L) is below the tap water PRG of 4.0 µg/L.

#### 7.4.2.4 Site 11 - Wood Hogger

The objective of the HHRA conducted at Site 11 (Wood Hogger) was to evaluate the potential cancer risks and noncancer health hazards associated with COPCs in surface soil (0 to 0.5 feet bgs), subsurface soil (0 to 10 feet bgs), sediment, and surface water at the site. The risk characterization results for Site 11 are summarized in Tables 7-10 (industrial scenario) and 7-11 (residential scenario). Tables M-40 through M-51 in Appendix M present the chemical-specific and multichemical total cancer risks and hazard indices associated with industrial and residential exposure scenarios to all COPCs identified at the site.

**Soil – Industrial Scenario:** The RME cancer risk estimates for an industrial worker exposure scenario based on surface soil ( $2.1 \times 10^{-5}$ ) and subsurface soil ( $1.9 \times 10^{-5}$ ) are within the target risk range. For both depth intervals evaluated, the risk estimates are attributed to arsenic, benzo(a)pyrene, dibenz(a,h)anthracene, and dioxins and furans. The RME concentrations of arsenic in surface soil (12.1 mg/kg) and subsurface soil (10.7 mg/kg) are below the ambient level for arsenic (27 mg/kg). The RME concentrations of benzo(a)pyrene and dibenz(a,h)anthracene are comparable to ambient PAH levels in urban and rural soils (ATSDR 1995). The RME hazard indices for an industrial exposure scenario based on COPCs in surface (0.03) and subsurface soil (0.02) are below the threshold value of 1 indicating no appreciable risk of adverse noncarcinogenic health effects.

The cancer risk estimates associated with dioxins and furans in surface and subsurface soils ( $1.1 \times 10^{-5}$ ) is based on the maximum detected TCDD TEQ concentration (0.000343 mg/kg). A total of two dioxins (1,2,3,4,6,7,8-HPCDD and OCDD) and two furans (1,2,3,4,6,7,8-HPCDF and octachlorodibenzofuran [OCDF]) were detected at the site. All four congeners were detected in two of 11 samples taken at the site; seven of the 11 samples taken resulted in either no detected congeners or OCDD being the only detected congener.

**Soil – Residential Scenario:** The RME cancer risk estimates for a residential exposure scenario based on COPCs in surface soil ( $1.6 \times 10^{-4}$ ) and subsurface soil ( $1.5 \times 10^{-4}$ ) exceed the target risk range. For both depth intervals evaluated, the risk estimates can be attributed primarily to arsenic, the carcinogenic PAHs, and dioxins and furans. As stated above, the RME concentrations of arsenic in surface soil and subsurface soil are below the ambient level for arsenic. The risk estimates associated with residential exposure to ambient levels of arsenic is  $7.1 \times 10^{-5}$  (Table 7-13). The RME concentrations of the PAHs are comparable to background PAH levels in urban and rural soils

(ATSDR 1995). The risk estimate for dioxins and furans is based on the maximum detected concentrations at the site.

The total hazard indices associated with residential exposure to COPCs in surface soil and subsurface soil are 1.33 and 1.22, respectively. While the total hazard indices are greater than the threshold value of 1, the results of the segregated hazard indices do not exceed 1 for any toxicological endpoints, indicating no appreciable risk of adverse noncarcinogenic health effects (Tables M-48 and M-49).

**Surface Water – Industrial Scenario:** The RME cancer risk estimate for incidental dermal exposure in an industrial scenario based on COPCs in surface water is  $3.7 \times 10^{-8}$ . The RME hazard index is less than 0.01 indicating no appreciable risk of adverse noncarcinogenic health effects.

**Surface Water – Residential Scenario:** The RME cancer risk estimate for incidental dermal exposure in a residential scenario based on COPCs in surface water is  $5.2 \times 10^{-8}$ . The RME hazard index is less than 0.01 indicating no appreciable risk of adverse noncarcinogenic health effects.

**Lead Evaluation:** The RME lead concentrations in surface soil (101 mg/kg), subsurface soil (63.9 mg/kg), and sediment (52.2 mg/kg) are below the California-modified residential PRG (130 mg/kg) and the EPA Region IX industrial PRG of 1,000 mg/kg. For surface water, the lead concentration (1.4 µg/L) is below the tap water PRG of 4 µg/L.

#### **7.4.3 Uncertainty Associated with the Risk Assessment**

A number of uncertainties are inherent in the characterization of potential cancer risks and noncancer health hazards presented in this document. These uncertainties were generally associated with either (1) the sampling strategy and site characterization process or (2) the assumptions and extrapolations that comprise the risk assessment process, as discussed below.

##### **7.4.3.1 Data Evaluation and Identification of Chemicals of Potential Concern**

To identify COPCs for the human health risk assessment, the adequacy of site characterization data was reviewed, and a structured COPC selection process was employed.



## **Data Quality**

The RI data quality issues do not appear to be significant. Completeness goals were met, and the validated analytical results provide data rated as “definitive” which is acceptable for use in risk assessment. Laboratory detection limits were generally adequate for identifying COPCs at concentrations at or below the EPA target risk range. Sample quantitation limits, when elevated, do not appear to impair the ability to identify COPCs.

As explained in Section 7.1.2 and Appendix L, the following issues were noted regarding data quality. Of the soil analyses, the constituents arsenic, benzo(a)pyrene, bis(2-chloroethyl)ether, carbazole, chrysene, dibenz(a,h)anthracene, hexachlorobenzene, n-nitroso-di-n-propylamine, and dioxins and furans have DLs above residential PRGs. However, because the DLs for these compounds are less than an order of magnitude greater than the residential PRGs, these compounds can be detected if they are present at concentrations in the  $1 \times 10^{-5}$  or greater risk range. However, lower DLs and SQLs are not routinely attainable using conventional analytical techniques.

In addition, although hexavalent chromium detection limits were in the target risk range, a significant number of these data were rejected due to poor spike recoveries. One detection of hexavalent chromium was reported at Site 11 at a concentration below the residential PRG. Hexavalent chromium is evaluated at this site using the hexavalent chromium PRGs. The remainder of chromium samples were evaluated using the total chromium PRGs, which assumes a 1:6 ratio of hexavalent to trivalent chromium.

The above data quality issues may result in an underestimation of site risks. SI data quality issues prevented the use of the analytical data in the HHRA. However, the RI generally provided coverage of SI sampling locations.

## **Data Coverage**

The Tidal Area sites were extensively sampled during the Phase IA RI, CS, and SWMU investigations. Both purposeful and random samples were collected. The data provide thorough spatial coverage of the sites and reduce uncertainty regarding the HHRA results.

## **COPC Selection Process**

The primary uncertainty associated with the COPC selection process is the possibility that a chemical may be inappropriately identified as a COPC for evaluation in the risk assessment (that is, a detected chemical may be inappropriately excluded or included as a COPC). For the NWS SBD Concord Tidal Area sites, the only analytes that were excluded from designation as COPCs were metals detected at concentrations below ambient levels and essential nutrients. For this reason, it is unlikely that any chemicals were inappropriately excluded from the risk assessment. Issues related to selection of inorganic and organic COPCs are described in the following text.

As part of the COPC selection process, metal concentrations in soil samples collected from each of the sites were compared to ambient levels established for the Tidal Area Sites. The ambient levels were computed as the 99th percentile of the ambient data set. If any site sample contained the metal at concentrations greater than the ambient level, the metal was included as a COPCs. The derivation of ambient concentrations is discussed in Appendix E.

A small number of inorganic constituents were detected only at concentrations less than ambient levels. Because the 95 percent UCL concentrations do not appear to be significantly greater than ambient concentrations, the inorganic constituents included in the HHRA may not be attributable to site activities. This may result in an overestimation of site-related risks. However, more rigorous statistical comparisons of site to ambient conditions are not proposed at this time because cancer risk estimates and HQs associated with inorganic constituents are, with few exceptions, within target ranges for residential and industrial exposure scenarios.

### **7.4.3.2 Exposure Assessment**

Uncertainties were identified in two areas of the exposure assessment process: (1) identification of receptors and (2) the estimation of exposure point concentrations. Uncertainties in each of these areas are discussed in the following text.

#### **Identification of Receptors**

Receptors and exposure scenarios are identified based on observed and assumed land use and activity patterns of the current and future receptors. The actual land use and activity patterns at the sites are not identical to those used to develop the PRGs, thereby introducing uncertainties. For example, future

land use is assumed to be residential for all sites, but future land use is not expected to change from its current use as an open naval base.

### **Estimation of Exposure Point Concentrations**

As discussed in Section 7.2.4, the 95th UCL was used as the exposure point concentrations (compared with the PRGs) because the large number of samples collected at each site adequately characterized the nature and extent of chemical contamination. The use of 95th UCL concentrations is recommended by EPA for evaluating RME conditions. For small data sets, the 95th UCL often exceeded the maximum detected concentration at a site because the standard deviation associated with small data sets is high. Consequently, the maximum detected concentration (or the concentration of a single detected value) was often used as the RME concentration. The exposure point concentrations based on the maximum concentration or the 95th UCL are likely to overestimate the concentrations and associated risks at each site.

#### **7.4.3.3 Toxicity Assessment**

The primary uncertainties associated with the toxicity assessment are related to development of toxicity values for COPCs. Standard toxicity values (RfDs and SFs) were used by EPA Region IX to develop the PRGs used in this HHRA. The uncertainties associated with the unavailability of toxicity values for all COPCs and the chemical-specific factors for chromium are described in the following text.

#### **Unavailability of Toxicity Values**

The cancer risks and noncancer health hazards can be assessed only for those COPCs for which the relevant toxicity values are available. For COPCs for which an SF or RfD was available for only one route of exposure, route-to-route extrapolations were made in the derivation of the Region IX PRGs. These extrapolations will introduce some uncertainty into the risk and hazard estimates.

#### **Chromium Speciation**

The selection of the appropriate toxicity value for chromium depends on the chemical species of chromium that is encountered; hexavalent chromium is a potent carcinogen by the inhalation route, whereas trivalent chromium is not a carcinogen. Chromium occurs primarily in the trivalent form in nature. The trivalent chromium oxidation state is more stable than the hexavalent state. Hexavalent chromium is easily transformed to trivalent chromium in reducing environments and environments

containing reducing species, such as those found in acidic soils or soils that contain organic materials, iron, or dissolved sulfides (Fetter 1993).

Based on the history of activities at the NWS SBD Concord Tidal Area sites, hexavalent chromium was not expected to be detected. To confirm the absence of hexavalent chromium at these sites, select samples were analyzed for total chromium and hexavalent chromium. Results of these analyses showed no detections of hexavalent chromium with the exception of one detection at the Wood Hogger site. Consequently, total chromium results are likely to represent trivalent chromium concentrations except at the Wood Hogger site. However, because 68 percent of the hexavalent chromium data was rejected, some uncertainty is associated with the assumption that all chromium is in the trivalent form. To reduce the likelihood of a significant underestimation of cancer risks, total chromium concentrations for each site were compared to the EPA Region IX residential (210 mg/kg) and industrial (450 mg/kg) PRGs for chromium. These PRGs for total chromium assumes that 1/6 of the total chromium is present in the form of hexavalent chromium.

## **7.5 RISK ASSESSMENT SUMMARY AND CONCLUSIONS**

This section summarizes the results of the human health risk assessment conducted for the Naval Weapon Station Concord Tidal Area sites. The objective of the HHRA was to evaluate potential risks to human health associated with exposure to contaminated media at these sites under current and possible future land-use scenarios, assuming no subsequent cleanup actions will be taken. This HHRA is based on data collected from the Tidal Area sites during the Remedial Investigation. The data were compared to EPA Region IX residential and industrial PRGs, which corresponds to a cancer risk of  $1 \times 10^{-6}$  or a HQ of 1. COPCs are defined as all detected organic constituents and inorganic constituents detected in excess of ambient concentrations. Potential noncancer hazards associated with carcinogenic compounds were evaluated using the noncancer PRGs (when available) contained in the electronic version of the EPA Region IX PRGs.

Currently, base personnel do not work at any of the Tidal Area sites. However, based on current land use, an industrial worker is the most likely current receptor. Although very unlikely, a residential exposure scenario was evaluated to characterize the risk using the most conservative exposure assumptions. Consequently, both industrial and residential exposure scenarios were evaluated in the HHRA.

The following subsections identify the industrial and residential exposure scenario constituents at each site detected at concentrations for which the cancer risk estimate exceeded  $1 \times 10^{-6}$  or hazard indices exceed 1. A hazard index exceeding 1 indicates the potential for noncancer health effects. Each of the Tidal Area sites was evaluated separately and is discussed below.

#### **7.5.1 Site 1 - Tidal Area Landfill**

For an industrial exposure scenario, the RME cancer risk estimates for surface and subsurface soil are within the target risk range of  $10^{-6}$  to  $10^{-4}$  and the total hazard indices are below the threshold value of 1. For the industrial scenario, arsenic is the only constituent detected at concentrations for which the cancer risk estimate exceeds  $1 \times 10^{-6}$ . No source of arsenic was identified and site concentrations are comparable to ambient levels.

For a residential exposure scenario, the RME cancer risk estimates for surface and subsurface soil are within the target risk range. Cancer risk estimates for detected arsenic and benzo(a)pyrene in surface and subsurface soils exceed  $1 \times 10^{-6}$  at Site 1. Arsenic concentrations are comparable to ambient levels. Benzo(a)pyrene was detected in one surface soil sample at a concentration that is comparable to background levels in urban and rural soils.

The segregated hazard indices for both surface and subsurface soils exceed the threshold value of 1. Arsenic is the only constituent detected with an individual HQ greater than 1.

The cancer risk and noncancer hazard estimates calculated for the site are believed to result mostly from the presence of ambient concentrations of arsenic in the site soil and not from an anthropogenic source of arsenic. The cancer risk estimate for soil is within the target risk range for residential use. While the segregated hazard index slightly exceeds the threshold value of 1 for both surface and subsurface soils, remediation at the site would not be likely to reduce the segregated hazard index below 1, because the HQ for residential exposure to ambient levels of arsenic exceeds 1. Consequently, the results of the human health risk assessment indicate that no further action is warranted at this site.

#### **7.5.2 Site 2 - R Area Disposal**

For an industrial exposure scenario, the RME cancer risk estimates for surface and subsurface soil are within the target risk range and the total hazard indices are below the threshold value of 1. Arsenic is

the only identified constituent in soil at Site 2 for which the cancer risk estimate exceeded  $1 \times 10^{-6}$ . No source of arsenic was identified and site concentrations are comparable to ambient levels.

For a residential exposure scenario, the RME cancer risk estimates for surface and subsurface soil are within the target risk range and the segregated hazard indices do not exceed 1. Cancer risk estimates for arsenic, benzo(a)pyrene, and dibenz(a,h)anthracene at Site 2 each exceed  $1 \times 10^{-6}$  for both surface and subsurface soils. Benzo(a)pyrene and dibenz(a,h)anthracene were detected at concentrations comparable to background levels in urban and rural soils.

For surface water, the RME cancer risk estimates for both the residential and industrial exposure scenarios were below the risk range and the hazard indices were significantly below the threshold value of 1 indicating no appreciable risk of adverse noncarcinogenic health effects.

The cancer risk and noncancer hazard estimates calculated for the site are believed to result mostly from the presence of ambient concentrations of arsenic in the site soil and not from an anthropogenic source of arsenic. The estimated cancer risk is within the target risk range and the segregated hazard indices do not exceed 1 indicating no appreciable risk of adverse noncarcinogenic health effects. The results of the human health risk assessment indicate that no further action is warranted at this site.

### **7.5.3 Site 9 - Froid and Taylor Roads**

For an industrial exposure scenario, the RME cancer risk estimates for surface and subsurface soil are below the target risk range and the hazard indices are below 1 indicating no appreciable risk of adverse noncarcinogenic health effects.

For a residential exposure scenario, the RME cancer risk estimates for surface and subsurface soil are within the target risk range and the segregated hazard indices are below 1. The cancer risk estimates for benzo(a)pyrene at Site 9 exceed  $1 \times 10^{-6}$  for both surface and subsurface soils. Benzo(a)pyrene was detected at a concentration comparable to background levels in urban and rural soils. Site soil lead concentrations exceed residential PRGs.

For surface water, the RME carcinogenic risk for both the residential and industrial exposure scenarios is within the risk range and the hazard indices are below 1. Arsenic was the only constituent detected for which the cancer risk estimate exceeds  $1 \times 10^{-6}$ .

The cancer risk estimates for the site are within the target risk range and the hazard indices are below 1 for both residential and industrial exposure scenarios. For the residential exposure scenario, the lead concentration in one surface soil sample exceeded the EPA Region IX residential PRG. Consequently, the results of the HHRA indicate that no further action is warranted at this site for the current land use. If residential development is considered for the site in the future, a site-specific lead cleanup concentration should be developed in consultation with EPA and DTSC.

#### **7.5.4 Site 11- Wood Hogger**

For an industrial exposure scenario, the RME cancer risk estimates for surface and subsurface soil are within the target risk range and the hazard indices are below the threshold value of 1. Cancer risk estimates for arsenic, benzo(a)pyrene, dibenz(a,h)anthracene, and dioxins and furans detected at Site 11 exceed  $1 \times 10^{-6}$ . No source of arsenic was identified. Benzo(a)pyrene and dibenz(a,h)anthracene were detected at concentrations comparable to background levels found in urban and rural soils. Dioxins and furans were detected near the southern end of the site near the old incinerator. Previous operations at the site included wood incineration, and it is likely that incineration of treated wood contributed to dioxins and furans at the site.

For a residential exposure scenario, the RME cancer risk estimates for surface and subsurface soil slightly exceed the target risk range and the segregated hazard indices are below the threshold value of 1 indicating no appreciable risk of adverse noncarcinogenic health effects.

Dioxins and furans provide the primary contributions to cancer risk estimates exceeding  $1 \times 10^{-6}$ . Lesser contributions are provided by arsenic and the carcinogenic PAHs detected (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene).

For surface water, the Site 11 RME cancer risk estimates for both the residential and industrial exposure scenarios were below the risk range and the hazard indices were significantly below the threshold value of 1.

The cancer risk estimates for Site 11 are within the target risk range for the industrial exposure scenario. If land use at the site remains the same as under current conditions, no further action is warranted. However, if higher site activity similar to a residential use scenario is anticipated in the future, the extent of dioxins at the southwestern portion of the site should be further evaluated.





## 8.0 CONTAMINANT FATE AND TRANSPORT

The fate and transport of contaminants depend on the physical and chemical properties of the chemicals released, the nature of the release, and the physical, chemical, and biological characteristics of the environment into which the contaminants have been released. At the Tidal Area sites, contaminants have been released to surface soil, subsurface soil, and surface water. Groundwater samples were collected and analyzed for the "Confirmation Groundwater Sampling Technical Memorandum" (TiEMI 1998b). The confirmation groundwater sampling and analysis did not detect contaminants released to groundwater. Although contaminants have not been detected consistently in groundwater, groundwater remains a potential migration pathway and is discussed as such in this section. The potential migration routes of chemicals at these sites were previously described in Sections 6.1.4 (Tidal Area Landfill Site), 6.2.7 (R Area Disposal Site), 6.3.5 (Froid and Taylor Roads Site), and 6.4.7 (Wood Hogger Site). The risk drivers were identified in Section 7.5 of the HHRA and are listed in Table 8-1. This section summarizes physical and chemical processes that govern fate and transport of risk drivers; reviews the factors that affect persistence of risk drivers in soil and surface water; and discusses processes that affect site-specific contaminant migration.

Risk for exposure to TPH was not evaluated at the Tidal Area sites because no EPA toxicity values exist for TPH. The absence of toxicity values for TPH is a result of its variable composition that results from the vast number refining methods and locations of origin. Physical and chemical properties of TPH are also variable. The extent of TPH contamination detected at the Tidal Area sites was limited and TPH in the Tidal Area sites was composed of heavier fractions. Heavier fractions remain because they degrade more slowly than the lighter fractions. In general, the remaining heavier fractions are less toxic than lighter fractions. The lack of toxicity values for TPH prevents TPH mixtures from being evaluated in the HHRA. Although TPH mixtures cannot be evaluated, specific constituent of TPH such as PAHs and BTEX are evaluated in the HHRA. Classes of specific TPH constituents, such as VOCs and SVOCs, are evaluated in the HHRA and are included in the fate and transport discussions of this section. TPH mixtures are not considered in Sections 8.1 through 8.3, however, TPH is discussed in Section 8.4, Site-Specific Fate and Transport.

Sections 8.1 through 8.4 describe the following:

- Physical and chemical processes governing fate and transport of site-related risk drivers in soil and surface water

- Physical and chemical characteristics of site-related risk drivers that affect their mobility and persistence in the environment
- Estimated potential mobility of site-related risk drivers

## **8.1 PHYSICAL AND CHEMICAL PROCESSES AFFECTING FATE AND TRANSPORT**

Physical processes that affect fate and transport of aqueous and nonaqueous constituents include photolysis, volatilization, advection, dispersion, molecular diffusion, and nonaqueous-phase liquid (NAPL) transport. Principal chemical processes include water solubility, sorption and desorption, hydrolysis, oxidation-reduction reactions, precipitation and dissolution reactions, and biological processes. Each process is discussed in the following subsections.

### **8.1.1 Photolysis**

Photolysis occurs naturally by free radical degradation after exposure to light. Because light is the necessary component, this process is only important in the fate of chemicals in surface soils and surface water. In general, the PAH risk drivers undergo rapid photolytic degradation under ordinary conditions; it may be an important factor in determining the fate of these compounds in surface soils and surface water at Tidal Area sites. In particular, photolysis is assumed to be the primary degradation mechanism for the petroleum-based product applied to surface water bodies for mosquito control (discussed in Section 2.7).

### **8.1.2 Volatilization**

Compounds with high vapor pressures and low solubilities undergo a phase change from a solution or pure phase to a gaseous phase. Volatilization can occur both in the surface and subsurface environment. Temperature, pressure, constituent concentration, area of the solution-air interface, and degree of sorption all affect the rates of volatilization. Contaminants volatilized from the surface go directly to the atmosphere; however, subsurface volatilized compounds follow a complex path that may result in resorption of contaminants. The volatility of a compound can be described using the Henry's Law constant (Table 8-2). A compound's volatility is significantly affected by temperature and chemical composition of the liquid. Constituents with a Henry's Law constant of less than  $10^{-7}$  atmosphere-cubic meter per mole ( $\text{atm}\cdot\text{m}^3/\text{mol}$ ) are considered nonvolatile; those between  $10^{-7}$  and  $10^{-5}$   $\text{atm}\cdot\text{m}^3/\text{mol}$  will volatilize slowly. Volatilization increases and becomes an important transfer

mechanism at Henry's Law constants of greater than  $10^{-5}$  atm-m<sup>3</sup>/mol (Montgomery and Welkom 1991). Based on the Henry's Law constants, the fate and transport of chemicals from volatilization are probably minor and may occur for some of the PAHs such as benzo(a)pyrene, which is found in soils at all of the Tidal Area sites. However, volatilization from soil would be further minimized by the seasonal flooding of Sites 2, 9, and 11.

### **8.1.3 Advection**

Advection is the process by which dissolved chemicals are transported by the bulk motion of flowing groundwater. As previously mentioned, contaminants do not appear to have been released to groundwater in the Tidal Area because no plume of contaminants downgradient of potential source areas has been discovered. Where advection occurs, nonreactive, nonsorbing constituents such as chloride are transported at an average rate equal to the average linear velocity (hereafter referred to as velocity) of groundwater flow. In flow systems dominated by advection, the chemical front of a compound migrating from a contaminant source generally remains well defined, and the chemical tends to be transported as a slug. In addition, the contaminant concentration at a point downgradient of the source tends to increase rapidly with time when the chemical front approaches.

In contrast, the chemical front tends to spread out in a system in which dispersion or molecular diffusion is as dominant, or more dominant, than advection. In this case, the concentration at a downgradient location increases more gradually when the chemical front arrives. As a result of advection, dissolved nonreactive chemicals (chemicals that do not adsorb to or otherwise interact with the geologic matrix or in response to changes in chemical equilibrium) are transported at the same rate as the groundwater flow. Advective processes at the Tidal Area do not appear to play a significant role because no plume of groundwater contamination has been detected.

### **8.1.4 Dispersion and Molecular Diffusion**

Dispersion in porous media refers to the spreading of a given volume of chemical as it flows through the subsurface from spatial variations in hydraulic conductivity. The type of dispersion that occurs as part of contaminant transport in groundwater is generally referred to as hydrodynamic dispersion. Hydrodynamic dispersion includes mechanical mixing (mechanical dispersion) during fluid advection, as well as molecular diffusion. Mechanical dispersion could occur during groundwater transport of

chemicals between fill material, which has a high hydraulic conductivity, and Bay Mud, which has a low hydraulic conductivity.

Molecular diffusion is the process whereby chemicals move from points of higher concentration to points of lower concentration under the influence of the compound's kinetic activities. The effect of diffusion on chemical transport is a function of the concentration gradient and the diffusion coefficient. Dispersion and diffusion do not appear to be occurring to a significant degree within the Tidal Area sites because groundwater contamination has not been detected.

#### **8.1.5            Nonaqueous-Phase Liquid Transport**

Organic chemicals can migrate through porous media by being completely dissolved in water, by containing components that are only partly dissolved in water, or by being a separate organic-phase liquid that is immiscible in water. The following discussion addresses immiscible NAPL transport.

The density and viscosity of NAPLs control the transport of these substances. Organic liquid that is less dense than water (for example, petroleum hydrocarbon distillates such as gasoline) have a specific gravity of approximately 0.7 and, therefore, float on water. This type of organic liquid is called light NAPL (LNAPL). The spread of LNAPL is largely related to the hydraulic conductivity of the porous medium and localized hydraulic gradient. Most halogenated hydrocarbons (for example, trichloroethene [TCE]) have specific gravities much greater than 1 and sink in water; these are called dense NAPLs (DNAPL). The spread of DNAPL is largely uncoupled from the hydraulic gradient that drives the advective transport of the dissolved contaminants. Movement of DNAPL may have a significant downward component, but the ability of DNAPL to migrate is influenced substantially by their viscosity and surface-wetting capabilities in water (Schwille 1988).

In addition, organic liquids such as halogenated aliphatics are spread by capillary action in an aquifer and leave free-phase liquid behind at 0.3 to 5 percent pore space volume (Schwille 1988). The NAPL residuals do not continue to migrate, but remain in place in the form of droplets. Over time and with water contact, the residual droplets provide a long-term source of contamination (Powers and others 1991). Based on the low levels of organic compounds detected in the soil and surface water samples, NAPL transport is not suspected at the Tidal Area sites.

### **8.1.6 Water Solubility**

The solubility of chemicals in water is a function of temperature and specific properties of the chemical species. Table 8-2 presents water solubilities for the organic risk drivers identified at the Tidal Area sites. The larger the solubility value, the greater the amount of chemical that will dissolve in water.

Organic constituents have not been detected consistently in wells at the Tidal Area sites. No evidence suggests that organic constituents are significantly dissolving in groundwater in any of the Tidal Area sites.

### **8.1.7 Sorption and Desorption**

Sorption is the process of binding or holding the chemical constituents tightly within the porous matrix, so they cannot be easily leached or transported. The sorption process depends on specific properties of both the chemicals and the soil or aquifer materials. The sorption process is reversible, and desorption can occur in response to changing chemical conditions such as pH. Clay materials have strong sorptive properties, and the substantial clay content in Tidal Area Bay Mud would likely impede chemical movement in the subsurface.

Table 8-2 presents data on the organic carbon partition coefficient ( $K_{oc}$ ). The  $K_{oc}$  quantifies the affinity of the chemical to sorb to organic matter. The larger the  $K_{oc}$ , the greater the preference for the chemical to sorb to organic matter. Risk drivers detected at the Tidal Area sites exhibit high  $K_{oc}$  values and thus would have a strong affinity for organic matter contained in site surface and subsurface soils. The high  $K_{oc}$  values also indicate that the risk drivers will tend to partition to the solid phase and not into aqueous or gaseous phases. The abundance of organic carbon at the Tidal Area sites provides a ready matrix for chemical sorption. TOC values were as high as 40 percent in some of the soil samples.

### **8.1.8 Hydrolysis**

Hydrolysis is the decomposition of an organic compound, or a metal ion complex, through a reaction with water. The process consists of an exchange between the hydroxyl ion ( $OH^-$ ) of a water molecule and an ionic group from the chemical compound, resulting in decomposition of the compound.

Acid-base hydrolysis of a chemical compound results in the formation of a weak acid, base, or both. Acid-base hydrolysis controls hydrogen and hydroxyl ion concentration and thus affects the pH of the

medium. Hydrolysis reactions may ultimately influence the leachability of inorganic chemicals in the Tidal Area soil because the solubility and mobility of inorganic compounds in soil are largely controlled by pH. For organic chemicals at the Tidal Area sites, hydrolysis is likely insignificant compared to processes such as biodegradation (Section 8.1.11).

#### **8.1.9            Oxidation-Reduction**

An oxidation reduction reaction results when a reacting chemical species (oxidizing agent) accepts electrons from other substances and is thereby reduced, while the reactant (reducing agent) donates electrons to other substances and is oxidized. Changes in oxidation state result in changes in sorption, solubility, toxicity, and other chemical characteristics. The potential importance of oxidation-reduction processes for Tidal Area sites is through the biologically mediated reaction of organic compounds. For example, sulfate-reducing bacteria may use sulfate ( $\text{SO}_4^{2-}$ ) as an oxidizing agent to convert sulfate and organic compounds to sulfide and inorganic carbon. Oxidation-reduction reactions are not considered to have a dominant influence on the fate and transport of chemicals for Tidal Area sites.

#### **8.1.10          Precipitation and Dissolution**

Precipitation occurs when the concentration of a chemical compound in solution exceeds the solubility limit. Inorganic compounds usually form a solid precipitate, while organic compounds form a liquid phase separate from the solvent. Dissolution is essentially the reverse of precipitation. Dissolution occurs when a chemical compound undergoes a phase change from a solid to a liquid. Precipitation and dissolution are influenced by temperature, pressure, concentration, ionic species activity, pH, and ionic strength of the solution. Precipitation and dissolution reactions are likely important in the seasonal surface water ponds at Sites 2, 9, and 11. High evaporation rates during summer months result in concentrating solutes in the ephemeral pools as evidenced by precipitation of salts observed around the pond perimeter during site visits and field sampling.

#### **8.1.11          Biological Processes**

Biological processes within the surface and subsurface soil modify the concentration and structure of chemicals in the environment. Biological processes of concern at the Tidal Area sites include bioaccumulation, bioconcentration, and biodegradation. Bioaccumulation is the general process by which organisms take up chemicals from water or by consuming food containing the chemicals. Bioconcentration is the process by which there is a net accumulation of a chemical in the organisms

through uptake. Biodegradation is a general process involving microorganisms by which a chemical is destroyed or transformed into other, usually less harmful, forms. Biodegradation of risk drivers is influenced by microbial populations, oxygen, soil moisture content, temperature, pH, and the availability of nutrients. Biodegradation is likely an important process influencing the fate and transport of risk drivers at Tidal Area sites due to the presence of organic constituents in soils.

## **8.2 PERSISTENCE OF ORGANIC CHEMICALS OF CONCERN**

Each of the processes described in Section 8.1 depends on the physical and chemical properties of the organic compound and the physical and chemical properties of the soil and water. Physical and chemical factors were compiled for each of the site-related risk drivers detected at the Tidal Area sites (Table 8-2). The net effect of these factors is a time-dependent redistribution (transport and fate) of the risk drivers in the water, soil, and air phases.

The octanol water partition coefficient ( $K_{ow}$ ) is useful in predicting the behavior of organic chemicals, particularly the affinity of a chemical for sorption by organic matter and its bioconcentration into biota. The coefficient ( $K_{oc}$  discussed in Section 8.17) is also useful in predicting sorption by soil or aquifer materials when the percent organic matter is known or can be estimated. The mobility of risk drivers in the soil solution can be predicted using the  $K_{ow}$  and  $K_{oc}$  values.

The persistence of chemicals in the environment is important in assessing how rapidly a risk driver may degrade in the environment. Table 8-3 summarizes organic chemical persistence data for the Tidal Area risk drivers gathered from Howard and others (1991). These criteria are commonly presented in days for the chemical to be degraded by abiotic (for example, hydrolysis) or biotic processes to a concentration one-half of the original concentration. The criteria is expressed in a unit, referred to as the half-life.

The physiochemical data from Table 8-2 and the persistence data from Table 8-3 were applied to evaluate site-related risk drivers for overall mobility potential. Each chemical was rated as low, medium, or high for mobility, volatilization potential, and persistence in groundwater and surface water. Table 8-4 presents the results of this evaluation.

In general, organic risk drivers at the Tidal Area sites have low to medium mobility, low persistence in surface water, and high persistence in groundwater (Table 8-5). Of particular importance at the Tidal Area sites is the low mobility associated with the  $\log K_{oc}$  values greater than 2.7. This low mobility in

combination with the high TOC content of Tidal Area soil is a principal factor in retarding risk driver transport. This retardation is evidenced by the higher concentrations of risk drivers in surface soil compared to subsurface soil (depths greater than 2.5 feet bgs).

### **8.3 PERSISTENCE OF INORGANIC CHEMICALS OF CONCERN**

The chemical attenuation and resulting persistence of inorganic risk drivers in the Tidal Area soil was evaluated based on two major types of reactions: (1) precipitation and dissolution (including oxidation-reduction); and (2) sorption and desorption and ion exchange.

Understanding the chemical form or aqueous speciation for each chemical and compound is important in evaluating the potential for either type of attenuation. The chemical's speciation may be as a monomolecular-charged species, or as some complex charged formation. Speciation can significantly affect the mobility of metals primarily because of its effect on a metal's aqueous solubility, the retention strength of the metal on the exchange site, and the sorption potential of inorganic chemicals within the porous medium.

The precipitation of inorganic minerals from solution is largely controlled by the concentration of calcium carbonate or hydroxides, and by the percentage of organic materials or clay. The solubility of calcium carbonate is affected by carbonate equilibria, including the partial pressure of carbon dioxide, the pH of the solution, and the concentration of calcium present. The concentration of carbon dioxide in natural and agricultural soil may be 100 times or more higher than the level in the atmosphere (Bolt and Breggenwert 1978). Calcium carbonate solubility is strongly influenced by the pH of the soil solution.

The persistence of inorganic constituents in Tidal Area soils is also influenced by other factors that affect the precipitate or coprecipitate (a minor component precipitating with another more major component) of metals. Many metal ion species have been shown to incorporate themselves into coatings on grains by coprecipitation effects with calcite and other alkaline earth carbonates.

Coprecipitation with other mineral phases, such as ferric oxyhydroxides, has also been postulated (Hem 1989). Aluminum, iron, and manganese are known to form amorphous precipitates of oxides and hydroxides that become the basis for the sorption sites for other metals.

Another major reaction affecting the attenuation of metals in soils is oxidation-reduction. For the Tidal Area sites, the potential for reducing conditions is prevalent because of the anoxic soil environment.



The reducing environment in the source area has resulted in conditions favorable for precipitation or coprecipitation of metals, which may have resulted in a high level of attenuation and limited migration of inorganic risk drivers.

Sorption and desorption and ion exchange reactions also influence the persistence of inorganic constituents as potential contaminant sources at the Tidal Area sites. Sorption occurs when an ion or molecule becomes attached to the surface of a solid particle such as a clay. Metals are also known to sorb to oxides and oxyhydroxides of aluminum, iron, and manganese in the subsurface. In systems with hydrous oxides, it is often difficult to differentiate among coprecipitation, sorption, and ion exchange.

The ion exchange capacity for soils is pH dependent and increases with increasing pH. Clays and oxides at neutral pHs have relatively high ion exchange capacities. Soil, in general, carries a net negative charge and, therefore, has a greater affinity for cations (positively charged ions) than for anions (negatively charged ions). Cation exchange capacities (CEC) for common soil constituents range from 3 to 150 milliequivalents per 100 grams (mEq/100g) for clay. Soil organic material may have a CEC of 100 to 350 mEq/100g (Dragun 1988). Tidal Area soils typically have a high clay and organic matter content.

## **8.4 SITE-SPECIFIC FATE AND TRANSPORT**

Based on the previous discussion of general fate and transport mechanisms, the following section describes the fate and transport of residential scenario risk drivers summarized in Table 8-1, and all TPH detected at the Tidal Area sites. Residential scenario risk drivers are discussed because the residential scenario is more conservative than the industrial scenario; therefore, the scenario risk drivers include all of the industrial scenario risk drivers plus other chemicals identified as risk drivers under the residential scenario.

### **8.4.1 Site 1 - Tidal Area Landfill**

The risk drivers identified for soils at the Tidal Area Landfill are benzo(a)pyrene and arsenic. Surface water is not present at the site, so no risk drivers exist for this media. Benzo(a)pyrene was detected in one surface sample (TLSSB004) collected from the western edge of the landfill at a concentration of 68  $\mu\text{g/kg}$ , which exceeded the PRG of 56  $\mu\text{g/kg}$  (Exhibit 2). Benzo(a)pyrene has low mobility, which indicates that it will remain sorbed to soil and potentially be transported from erosion soil by wind or

surface water. However, if the PAHs desorb into surface water, their persistence is low and they will degrade quickly (Table 8-5).

Arsenic was detected at concentrations exceeding the estimated ambient concentration along the western and southern edges of the landfill. The most likely transport mechanism for these metals would be from erosion of the soil by surface water or wind; however, wind will not be a potential pathway once the landfill is capped under the presumptive remedy. As stated in Section 6.1.2.2, arsenic has been detected throughout both the Tidal Area and the Inland Area of NWS SBD Concord (PRC and Montgomery Watson 1996) at concentrations exceeding PRGs, indicating that such elevated concentrations represent native soil characteristics. Estimated ambient concentrations for arsenic in the Tidal Area also greatly exceed the PRG concentration (27 mg/kg compared to 0.38 mg/kg). Soil beneath ponded areas contains small soil particles that are transported by surface water and then settle out when the surface water ponds. As stated in Section 8.3, the number of sorption sites in a soil will influence the amount of metal contained in the soil. As the particle size decreases, the relative surface area increases, which in turn increases the relative number of sorption sites (Fetter 1988). Therefore, the soil beneath ponded water may have a higher sorbed metal content than will other site soils.

The Tidal Area Landfill Site risk drivers could also be transported by groundwater. The flow velocity of groundwater through Bay Mud is so slow that this pathway is not considered viable; however, the flow of groundwater through fill (for example, landfill waste and construction fill) is a viable pathway. The transport of risk drivers by groundwater would depend on risk drivers desorbing into the groundwater, or the groundwater transporting small soil particles with sorbed risk drivers. The lack of risk drivers in surface water at the other Tidal Area sites indicates that the risk drivers have an affinity for soil; therefore, groundwater transport of risk drivers is assumed to be limited.

#### **8.4.2 Site 2 - R Area Disposal**

The risk drivers identified for soil at the R Area Disposal Site are PAHs (benzo[a]pyrene and dibenz[a,h]anthracene) and arsenic. No risk drivers were identified for surface water at the site. As described in Section 6.2.3.1, PAHs may occur from waste disposed of on site and airborne deposition and runoff of smoke and vehicle exhaust. The PAH concentrations exceeding PRGs were detected in samples collected from two distinct portions of the site: in soil and sediment from the northwestern portion of the site along Otter Sluice and Baker Road, and in the soil from the drainage ditch that runs along the southern portion of the site (Exhibit 2). These PAHs have low mobility, which indicates that

they will remain sorbed to soil and potentially be transported by soil erosion from surface water runoff. However, if these PAHs desorb into surface water, their persistence is low and they will degrade quickly (Table 8-5). The limited fate and transport of these PAHs is further supported by the fact that the PAHs are limited to two distinct areas. No SVOC were detected in surface water samples from the site; therefore, the PAHs appear to remain sorbed to the soil.

The most likely transport mechanism for arsenic is erosion of the soil by surface water. Arsenic was detected in soils collected at locations throughout the site. Arsenic was detected in surface water samples at concentrations exceeding the screening criteria, but not at concentrations sufficient to identify it as a risk driver for surface water. The arsenic in the surface water may be from arsenic desorbing from site soil, or it may exist in the surface water entering the site. As stated in Section†6.2.3.2, most arsenic concentrations were less than the estimated ambient concentration, although higher than the PRGs. Because it is found throughout the Tidal Area sites and in the upland soil (Exhibit 3) (PRC and Montgomery Watson 1996), arsenic concentrations likely represent native soil conditions.

R Area Disposal Site risk drivers could also be transported by groundwater. The flow velocity of groundwater through Bay Mud is so slow that this pathway is not considered viable. However, the flow of groundwater through fill (for example, berm fill) is a viable pathway although there is no evidence that groundwater transport is occurring. The transport of risk drivers by groundwater would depend on risk drivers desorbing into the groundwater, or on the groundwater transporting small soil particles with sorbed risk drivers. The lack of PAHs and arsenic in surface water samples collected from the site indicates that these chemicals have an affinity for soil; therefore, groundwater transport of these chemicals is assumed to be limited.

#### **8.4.3 Site 9 - Froid and Taylor Roads**

The risk drivers identified for soil at the Froid and Taylor Roads Site are benzo(a)pyrene and lead. Arsenic was identified as a risk driver for surface water at the site. As described in Section 6.3.2.1, benzo(a)pyrene may result from airborne fallout and runoff of wood smoke and vehicle exhaust. Benzo(a)pyrene concentrations greater than PRGs were detected in soils collected along the eastern and southeastern portions of the site adjacent to Taylor Road (Exhibit 2). Benzo(a)pyrene has a low mobility, and therefore will most likely remain sorbed to soil and be transported by soil erosion from surface water. However, if benzo(a)pyrene does desorb into surface water, it has low persistence in

surface water and will degrade quickly (Table 8-5). No PAHs were detected in the surface water samples from the site, which indicates that the benzo(a)pyrene remains sorbed to the soil.

The most likely transport of arsenic would be erosion of the soil by surface water. Arsenic was detected in all surface water samples collected at the site. The arsenic in surface water may be from arsenic desorbing from site soil or it may exist in the surface water entering the site. As stated in section 6.2.3.2, most concentrations of arsenic are less than the estimated ambient concentration, although they are higher than the PRGs.

Lead was detected in four soil samples at concentrations exceeding PRGs. The most likely transport mechanism for lead would involve erosion of soil by surface water.

The Froid and Taylor Roads Site risk drivers could also be transported by groundwater. The flow velocity of groundwater through Bay Mud is so slow that this pathway is not considered viable; however, the flow of groundwater through fill (for example, construction and road fill) is a viable pathway. The transport of risk drivers by groundwater would depend on risk drivers desorbing into the groundwater, or on the groundwater transporting small soil particles with sorbed risk drivers. The lack of benzo(a)pyrene and infrequent lead in surface water samples from the site indicate that these compounds have affinity for soil; therefore, groundwater transport of benzo(a)pyrene and lead is assumed to be limited.

Risk from exposure of TPH was not evaluated because TPH is an amalgamation of organic compounds and no toxicity values for TPH exist. The concentrations of specific components of TPH, such as BTEX and PAHs, were assessed to determine if they should be classified as risk drivers. As described in Section 6.3.2.1, TPH quantified as motor oil may be present as a result of fuel releases alongside Froid Road or runoff from asphalt roads. TPH quantified as motor oil was detected in soil samples collected in most areas of the site. TPH quantified as diesel and motor oil was detected in surface water samples at the site. TPH quantified as diesel and motor oil, will eventually biodegrade in the soil and surface water.

#### **8.4.4 Site 11 - Wood Hogger**

The risk drivers identified for soil at the Wood Hogger Site are PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(h)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd) pyrene), dioxins, furans, and arsenic. No risk drivers were identified for surface water at this site.

As described in Section 6.4.3.1, PAHs may result from site activities, airborne deposition, and runoff of exhaust and smoke particles. Benzo(a)pyrene was detected in soil samples in the northern and southern areas of the site. The PAHs other than benzo(a)pyrene were detected only in soil samples collected around the wood hogger machinery and Building A-29 at SWMU 37 (Exhibit 2). All of the PAHs have low mobility; therefore, they will most likely remain sorbed to soil and may be transported by soil erosion from surface water runoff. However, if benzo(a)anthracene or benzo(a)pyrene desorb into surface water their persistence is low and they will degrade quickly (Table 8-5). The persistence of benzo(b)fluoranthene, benzo(k)fluoranthene, and dibenz(a,h)anthracene in surface water ranges from low to high, and the persistence of indeno(1,2,3-cd) pyrene is high, so these PAHs would persist if they desorbed into surface water. The limited fate and transport of benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene is further supported by the fact that they are limited to the southwestern corner of the site. No PAHs were detected in the surface water samples collected from the site, which indicates that the PAHs will remain sorbed to the soil.

As described in Section 6.4.3.1, dioxins and furans may result from the presence of PCP on site or from combustion of wood products in the former incinerator on site. Atmospheric fallout may also be a major contributor to ambient dioxin concentrations in soil (EPA 1994a). Samples analyzed for dioxins were collected from the area of the former incinerator, dioxins and were detected only on the eastern side of the incinerator. The mobility of dioxins is low, which indicates that it will remain sorbed to soil and potentially be transported by soil erosion from surface water runoff. However, if dioxins desorb into surface water, their persistence is high and they will degrade slowly (Table 8-5).

Arsenic is a risk driver for soil. Arsenic was detected only twice at levels exceeding the estimated ambient concentration and they were from soil samples collected along the northern and western edges of the site. Arsenic was detected in the surface water samples at concentrations exceeding the screening criteria, but not at concentrations sufficient enough to identify it as a risk driver for surface water. The arsenic in the surface water may be from arsenic desorbing from site soil, or the arsenic may exist in the surface water entering the site. As discussed earlier, the soil beneath ponded water may have a higher metal content than the other site soils.

The Wood Hogger Site risk drivers could also be transported by groundwater, although no plume of groundwater contamination has been detected at the site. The flow velocity of groundwater through Bay Mud is so slow that this pathway is not considered viable; however, the flow of groundwater through fill (for example, berm fill) is a viable pathway. The transport of risk drivers by groundwater

would depend on risk drivers desorbing into the groundwater, or on the groundwater transporting small soil particles with sorbed risk drivers. The lack of PAHs in surface water samples from the site indicates that these chemicals stay sorbed to soil; therefore, groundwater transport of these chemicals is assumed to be limited.

Risk from exposure of TPH was not evaluated because TPH is an amalgamation of organic compounds and no toxicity values for TPH exist. The concentrations of specific TPH components, such as BTEX and PAHs, were assessed to determine if they should be classified as risk drivers. As described in Section 6.4.3.1, petroleum hydrocarbons were detected near the wood hogger machinery, and probably resulted from fuel or oil releases from site equipment. TPH quantified as gasoline and TPH quantified as diesel and motor oil were detected in samples collected from the southwestern portion of the site. TPH will biodegrade with time (Rice and others [Lawrence Livermore National Laboratory] 1995).

## 9.0 CONCLUSIONS AND RECOMMENDATIONS

An RI was conducted at the Tidal Area sites at NWS SBD Concord, California. The following sites were included in this study: land at the perimeter of the Tidal Area Landfill (Site 1), R Area Disposal (Site 2), Froid and Taylor Roads (Site 9), and the Wood Hogger (Site 11). In addition to data collected for these sites, analytical data from soil samples collected during an RFA investigation of SWMU 37, located within the Wood Hogger Site, were included in this RI. Otter Sluice, which is located adjacent to the R Area Disposal Site and Wood Hogger Site, was also investigated as a part of the RI; however, the data were only included in the QEA (Volume II). The main purposes of the RI were to (1) characterize the geology and hydrogeology of the Tidal Area sites; (2) assess the nature and extent of soil, sediment, and surface water contamination at each site; (3) conduct a screening-level HHRA and QEA; and (4) assess the potential migration of chemical constituents found to present a potential risk to human health or the environment.

This section of the RI (Volume I, Section 9.0) provides the overall conclusions and recommendations for each of the Tidal Area sites. This section also summarizes all the findings of Volume I, including chemical characterization and human health risk assessment. The QEA, presented in its entirety in Volume II, separately describes the nature and extent of contamination relative to various ecological toxicity benchmarks, so the focus in the QEA is shifted toward ecological receptors and does not consider human health. Although this section summarizes all of Volume I, it provides only a general summary of Volume II. Volume II should be consulted for specific information regarding the QEA. The overall conclusions and recommendations considering risk to human health and ecological receptors are summarized in this section for all Tidal Area sites.

Remedial action under CERCLA is recommended in order to cap the Tidal Area Landfill, and planning for the cap construction has advanced past the FS stage. The ROD for a Tidal Area Landfill cap is in the draft final stage and is expected to be signed before the end of 1999.

The recommendations of this RI are based on human health and ecological risk evaluations. The Navy recommends no further evaluation or response action (no further action) for the Tidal Area sites with the exception of a landfill cap, which is in accordance with the presumptive remedy. Because the Navy does not recommend these sites for further action, the Navy does not recommend an FS. The Navy recommends that the R Area Disposal Site, the Froid and Taylor Roads Site, and the Wood Hogger Site proceed to a single no further action ROD. The land at the perimeter of the Tidal Area Landfill

Site should be included in the ROD for the R Area Disposal Site. This is appropriate because the R Area Disposal Site and the perimeter of the Tidal Area Landfill Site are visibly indistinguishable from each other, and there is no evidence of contamination posing a significant risk to human health or the environment.

A summary for each of the Tidal Area sites are presented in the following sections. Section 7.0, the HHRA, presents the evaluation of risks associated with both residential and industrial exposure scenarios. A residential scenario is highly unlikely to occur at any of the Tidal Area sites; therefore, only industrial risks are discussed in the conclusions and recommendations that follow.

The estimated human health risks and hazard indices that are summarized in this section provide bounding information that is useful for making decisions; however, the human health risks and hazard indices are not intended to be an accurate representation of actual site risks. Actual health risks are expected to be substantially lower than the EPA industrial exposure scenario, which assumes workers are on site for 250 days per year over a period of 25 years. Actual site use at the Tidal Area sites is restricted because NWS SBD Concord is not open to the public and workers are not ordinarily present at any of these sites. Base workers will occasionally be present for grounds maintenance and other limited duration work tasks. Future land use at NWS SBD Concord is not expected to change from its current use. The industrial site exposure assumptions vastly overestimate site use; therefore, the industrial exposure scenario human health risk estimates will correspondingly overestimate site risk.

## **9.1 TIDAL AREA LANDFILL SITE SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS**

The following sections summarize the chemical characterization (from a human health risk perspective) and the HHRA for the perimeter of the Tidal Area Landfill Site. In addition, the sections present human health and ecological risk assessment conclusions and overall recommendations for the perimeter of the Tidal Area Landfill Site.

### **9.1.1 Chemical Characterization**

Surface and subsurface soil sampling was conducted in the R Area Disposal Site along the perimeter of the Tidal Area Landfill Site to assess whether chemicals may be migrating from the landfill. The presumptive remedy approach is being followed at the Tidal Area Landfill Site; the RI made no attempts to further characterize the landfill contents by sampling and analyzing soil or debris from within the landfill.



Eight locations were sampled along the perimeter of the landfill, and 24 samples were analyzed; only one organic compound was detected in soil at a concentration greater than its residential PRG. The PAH benzo(a)pyrene was detected in the surface soil sample from the western edge of the landfill. Arsenic and lead were detected at concentrations greater than their residential PRGs and estimated ambient metal concentrations. Lead was detected in surface soil samples, and the source is unknown.

#### **9.1.2 Human Health Risk Assessment**

The objective of the HHRA conducted at the Tidal Area Landfill Site was to evaluate the potential carcinogenic risks and noncarcinogenic hazards associated with exposure to COPCs in soil. Soil was the only medium sampled in the R Area Disposal Site along the perimeter of the Tidal Area Landfill. This section summarizes risks associated with the industrial scenario.

For an industrial exposure scenario, the RME carcinogenic risk for surface soil ( $1.2 \times 10^{-5}$ ) and subsurface soil ( $6.8 \times 10^{-6}$ ) is within the target risk range of  $10^{-6}$  to  $10^{-4}$ , and the total hazard index is below the threshold value of 1. The risk is primarily attributed to arsenic. Arsenic concentrations detected in soil do not appear to be site related. No source of arsenic was identified, and the site RME concentrations are comparable to ambient levels.

#### **9.1.3 Qualitative Ecological Risk Assessment**

A complete description of the QEA is presented in Volume II of this report. This section summarizes the QEA for the area adjacent to the Tidal Area Landfill Site.

Soil, sediment, waste extraction test, and surface water samples from the perimeter of the Tidal Area Landfill Site were evaluated as part of the QEA to determine if receptors in this portion of the R Area Disposal Site are at risk from chemicals that may be migrating from the landfill. Chemicals of ecological concern were identified based on the exposure and effects assessment using lines of evidence such as toxicity-based benchmarks, bioassays, tissue residue levels, and information from the toxicological literature.

No inorganic chemicals exceeded the effects range-median (ER-M) values in more than one sample. For organic chemicals, exceedances of the ER-M for total PCBs and total chlordanes were based on the use of one-half the detection limit, versus actual detections. Maximum soil concentrations of nickel, zinc, DDTs, chlordanes, and low molecular weight PAHs exceeded the ER-M. Concentrations of

chemicals at the perimeter of the landfill were generally lower than those at the adjacent R Area Disposal Site.

In surface water, aluminum, copper, and nickel exceeded AWQCs during at least one sampling quarter. Of the organic chemicals detected in surface water, only chlordanes and PAHs exceeded AWQCs; however, most instances during which the AWQCs were exceeded for these organics were based on one-half the detection limit, as opposed to actual detection of the chemicals in the samples.

Plant and invertebrate benchmarks were not exceeded at the landfill perimeter locations, with the exception of zinc, which occurred at a maximum concentration of 743 mg/kg. No COECs for plants or invertebrates were identified.

Based on the food-chain model results, all HQ<sub>1</sub> (low dose/high toxicity reference value [TRV]), HQ<sub>3</sub> (high dose/high TRV), and HQ<sub>6</sub> (typical dose/high TRV) values were less than 1.0, indicating that there is no immediate or significant risk to birds and mammals from the chemicals in the R Area Disposal Site at the perimeter of the Tidal Area Landfill Site.

#### **9.1.4 Conclusions and Recommendations**

The human health risks and hazards calculated for the site are believed to result mostly from the presence of ambient concentrations of arsenic in the site soil, not from an anthropogenic source. The risk for soil is within the EPA's target risk range for industrial use. There is no strong indication of chemical migration from the Tidal Area Landfill Site to the R Area Disposal Site. The Tidal Area Landfill is expected to be capped in accordance with the presumptive remedy to comply with applicable regulations for landfill closure. A landfill cap will eliminate the potential for surface erosion of potential contaminants and should also reduce the possibility that contaminated leachate could form in the future either below or outside the limits of the existing landfill.

Based on the available lines of evidence, there is no significant or immediate risk to any ecological receptors at the perimeter of the Tidal Area Landfill Site, and no response action is recommended in this portion of the R Area Disposal Site to protect ecological receptors.

The results of both the HHRA and the QEA indicate that no further action is warranted in the R Area Disposal Site as a result of contaminant migration from the Tidal Area Landfill Site. Construction of

the presumptive remedy landfill cap over the landfill itself is the only recommended action for the Tidal Area Landfill Site.

## **9.2 R AREA DISPOSAL SITE SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS**

The following sections summarize the chemical characterization (from a human health risk perspective) and the HHRA for the R Area Disposal Site. In addition, the sections present HHRA and QEA conclusions and overall recommendations for the R Area Disposal Site.

### **9.2.1 Chemical Characterization**

Soil samples were collected across the for the R Area Disposal Site using purposive and unbiased sampling approaches. Under the purposive approach, samples were collected at suspected disposal locations identified in previous investigations. Under the unbiased approach, samples were collected from additional locations to provide an approximate uniform spatial coverage of the site. Surface water samples were collected across the site and in Otter Sluice.

Five SVOC compounds were detected in soil and sediment at concentrations greater than residential PRGs. The PAHs benzo(a)pyrene, dibenz(a,h)anthracene, benzo(a)anthracene, benzo(b)fluoranthene, and benzo(k)fluoranthene were detected in soil and sediment samples collected from the northwestern or southern portions of the site. Six metals (arsenic, barium, chromium, lead, nickel, and thallium) were detected across the site at concentrations greater than their residential PRGs and estimated ambient metal concentrations.

No SVOCs were detected in surface water at a concentration exceeding screening criteria (tap water PRGs). Five pesticides were detected in surface water at concentrations exceeding PRGs. The VOC chloromethane was detected once at a concentration exceeding its tap water PRG. Five metals were detected at concentrations exceeding screening criteria; aluminum, arsenic, lead, manganese, and thallium were detected in surface water samples from across the site, but not in surface water samples from Otter Sluice. The metal concentrations in these locations are likely elevated through concentration, which occurs during evaporation of surface water from the R Area Disposal Site.

### **9.2.2 Human Health Risk Assessment**

The objective of the HHRA conducted at R Area Disposal Site was to evaluate the potential carcinogenic risks and noncarcinogenic hazards associated with exposure to COPCs in soil and surface water at the site. This section summarizes risks associated with the industrial scenario.

For an industrial exposure scenario, the RME carcinogenic risks for surface soil ( $5.3 \times 10^{-6}$ ) and subsurface soil ( $5.8 \times 10^{-6}$ ) at R Area Disposal Site are within the target risk range of  $10^{-6}$  to  $10^{-4}$ , and the hazard indices are less than 1. Arsenic is the only constituent for which the risk estimate exceeds  $10^{-6}$ . Arsenic concentrations detected in soil do not appear to be site related. No source was identified, and site concentrations are comparable to ambient levels.

For surface water, the RME carcinogenic risk ( $1.7 \times 10^{-7}$ ) for the industrial exposure scenario was below the target risk range, and the hazard index was significantly below the threshold value of 1.

### **9.2.3 Qualitative Ecological Risk Assessment**

This section summarizes the QEA for the R Area Disposal Site. The QEA included soil, sediment, waste extraction test, surface water, and tissue samples that were collected throughout the R Area Disposal Site. Chemicals of ecological concern were identified based on the exposure and effects assessment using lines of evidence such as toxicity-based benchmarks, bioassays, tissue residue levels, and information from the toxicological literature.

Inorganic and organic chemicals that exceeded ER-M values in a few samples included lead, zinc, and 4,4-DDT. Lead exceeded ambient values in many samples but exceeded the ER-M in just five of 94 soil samples. Lead was (1) infrequently detected at elevated concentrations, (2) highest in areas of limited ecological value, (3) largely unavailable to biota due to neutral pH, and (4) not likely to migrate out of the R Area Disposal Site. Of the organic chemicals detected, only DDTs and chlordanes exceeded ER-Ms.

In surface water, lead, mercury, and zinc exceeded AWQCs in at least one sampling quarter. Of the organic chemicals detected in surface water, only chlordanes exceeded AWQCs; however, the exceedance of chlordanes was based on one-half the detection limit if these chemicals were not actually detected in the samples.

Lead was not detected in pickleweed tissues collected from the R Area Disposal Site, but did exceed AWQCs in surface waters, indicating some potential for risk to invertebrates and fish in aquatic portions of the R Area Disposal Site. Lead was detected in rodent tissues from the R Area Disposal Site. Limited risk to soil biota and terrestrial invertebrates was identified; however, this was based on a few limited exceedances of the available benchmarks. Review of the chemical distributions did not reflect widespread contamination nor indicate a potential source for these exceedances.

Based on the food-chain model results, all HQ<sub>1</sub> (low dose/high TRV), HQ<sub>3</sub> (high dose/high TRV), and HQ<sub>5</sub> (typical dose/high TRV) values were less than 1.0, indicating that there is no immediate or significant risk to birds and mammals from the chemicals at the R Area Disposal Site.

#### **9.2.4 Conclusions and Recommendations**

The human health risks and hazards calculated for the site result mostly from the presence of ambient concentrations of arsenic in the site soil, not from an anthropogenic source of arsenic. The risks associated with the presence of anthropogenic chemicals, such as PAHs, are at the lower end of the risk range. The risks for soil are within EPA's target risk range, and the hazard index for this site does not exceed the threshold value of 1.

Based on the weight-of-evidence evaluation, there is no significant or immediate risk to ecological receptors at the R Area Disposal Site, and no response action is recommended for the R Area Disposal Site to protect ecological receptors.

The results of both the HHRA and the QEA indicate that no further action is warranted at the R Area Disposal Site.

### **9.3 FROID AND TAYLOR ROADS SITE SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS**

The following sections summarize the chemical characterization (from a human health risk perspective) and the HHRA for the Froid and Taylor Roads Site. In addition, the sections present HHRA and QEA conclusions and overall recommendations for the Froid and Taylor Roads Site.

### **9.3.1 Chemical Characterization**

Soil samples were collected at suspected disposal locations identified in previous investigations and at additional locations that were intended to provide approximate uniform spatial coverage of the site. Four quarterly rounds of surface water samples were collected from two locations along the northern portion of the site in 1995 and 1996. In 1998, three additional surface water samples were collected and analyzed.

The PAH benzo(a)pyrene was the only organic compound detected in soil at a concentration greater than its residential PRG. Benzo(a)pyrene was detected in two soil samples collected from the southeastern portion of the site along Taylor Boulevard. TPH-e quantified as motor oil was detected in 15 of the 18 soil and sediment samples collected at the site. Arsenic, lead, and manganese were detected at concentrations greater than the residential PRGs and estimated ambient metal concentrations.

No organic compounds were detected in surface water at a concentration exceeding tap water PRGs. TPH-e quantified as diesel fuel was detected in most of the surface water samples collected at the site. Three metals were detected at concentrations exceeding screening criteria; arsenic and manganese were detected in all nine samples collected at the site, and thallium was detected in one of the nine samples at a concentration above its tap water PRG.

### **9.3.2 Human Health Risk Assessment**

The objective of the HHRA conducted at the Froid and Taylor Roads Site was to evaluate the potential carcinogenic risks and noncarcinogenic hazards associated with exposure to COPCs in soil and surface water at the site. This section summarizes risks associated with the industrial scenario.

For the industrial exposure scenario, the RME carcinogenic risk for surface soil ( $5.6 \times 10^{-7}$ ) and subsurface soil ( $5.5 \times 10^{-7}$ ) at the Froid and Taylor Roads Site is less than the target risk range of  $10^{-6}$  to  $10^{-4}$ , and the hazard indices are less than 1.

For surface water, the RME carcinogenic risk ( $3.5 \times 10^{-6}$ ) for the industrial exposure scenario was within the target risk range, and the hazard index was below the threshold value of 1.

### **9.3.3 Qualitative Ecological Risk Assessment**

This section summarizes the QEA for the Froid and Taylor Roads Site. The QEA included soil, sediment, waste extraction test, surface water, and tissue samples that were collected throughout the Froid and Taylor Roads Site. Chemicals of ecological concern were identified based on the exposure and effects assessment using lines of evidence such as toxicity-based benchmarks, bioassays, tissue residue levels, and information from the toxicological literature.

No inorganic chemicals exceeded the ER-M values in more than one sample. For organic chemicals, exceedances of the ER-M were based on the use of one-half the detection limit, versus actual detections. Chlordanes exceeded ER-M in four soil and sediment samples.

Chlordane levels in fish and amphipods collected at the site were lower than fish and invertebrate tissues reported in the Regional Monitoring Program (RMP) data (San Francisco Estuary Institute [SFEI] 1997).

Based on the food-chain modeling results, all HQ<sub>1</sub> (low dose/high TRV), HQ<sub>3</sub> (high dose/high TRV), and HQ<sub>5</sub> (typical dose/high TRV) values were less than 1.0 using the maximum concentrations of chlordanes, indicating that there is no immediate or significant risk to birds and mammals from the chemicals at the Froid and Taylor Roads Site.

Limited risk to soil biota and terrestrial invertebrates was identified; however, this was based on a few limited exceedances of the benchmarks. Review of the chemical distributions did not reflect widespread contamination nor indicate a potential source for these exceedances.

### **9.3.4 Conclusions and Recommendations**

The human health risks and hazards calculated for the site result from the presence of anthropogenic chemicals, such as PAHs, which occur at the lower end of the risk range. The risks for surface water are within the EPA's target risk range, and the hazard index for this site does not exceed the threshold value of 1.

Based on the available lines of evidence, there is no immediate or significant risk to ecological receptors at the Froid and Taylor Roads Site, and no response action is recommended to protect ecological receptors.

The results of the HHRA and the QEA both indicate that the site does not pose a significant or immediate risk to receptors. Therefore, no further action is recommended.

#### **9.4 WOOD HOGGER SITE SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS**

The following sections summarize the chemical characterization (from human health risk perspective) and the HHRA for the Wood Hogger Site. In addition, the sections summarize HHRA and QEA conclusions and overall recommendations for the Wood Hogger Site.

##### **9.4.1 Chemical Characterization**

Soil and sediment samples were collected across the site using purposive and unbiased sampling approaches. Under the purposive approach, samples were collected at suspected disposal locations identified in previous investigations. Under the unbiased approach, samples were collected from additional locations to provide approximate uniform spatial coverage of the site. Surface water samples were collected across the site and in Otter Sluice.

The PAHs benzo(a)pyrene, dibenz(a,h)anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene were detected in soil samples at concentrations exceeding residential PRGs in samples collected from the southwestern portions of the site near the Wood Hogger machinery. Dioxins and furans were detected in equivalent TCDD concentrations exceeding the residential PRG for TCDD soil samples at the southern end of the site near the old incinerator. Arsenic, cadmium, and lead were detected in soil samples at concentrations exceeding residential PRGs and estimated ambient metal concentrations in soil samples collected across the site.

No organic compounds were detected in surface water at concentrations exceeding tap water PRGs. Arsenic and manganese were detected in surface water samples at concentrations exceeding tap water PRGs.

##### **9.4.2 Human Health Risk Assessment**

The objective of the HHRA conducted at the Wood Hogger Site was to evaluate the potential carcinogenic risks and noncarcinogenic hazards associated with exposure to COPCs in soil and surface water at the site. This section summarizes risks associated with the industrial scenario.



For the industrial exposure scenario, the RME carcinogenic risk for surface soil ( $2.1 \times 10^{-5}$ ) and subsurface soil ( $1.9 \times 10^{-5}$ ) at the Wood Hogger Site is within the target risk range of  $10^{-6}$  to  $10^{-4}$ , and the hazard indices are less than 1. The estimate risk from arsenic, benzo(a)pyrene, dibenz(a,h)anthracene, and dioxins and furans each exceeded  $10^{-6}$  in both surface and subsurface soils. Arsenic concentrations detected in soil are comparable to ambient levels. Benzo(a)pyrene and dibenz(a,h)anthracene were detected at concentrations comparable to ambient levels in urban and rural soils.

For surface water, the RME carcinogenic risk was below the target risk range, and the hazard index was significantly below the threshold value of 1 for both industrial and residential exposure scenarios.

#### **9.4.3 Qualitative Ecological Risk Assessment**

This section summarizes the QEA for the Wood Hogger Site. The QEA included soil, sediment, waste extraction test, surface water, and tissue samples that were collected throughout the Wood Hogger Site. Chemicals of ecological concern were identified based on the exposure and effects assessment using lines of evidence such as toxicity-based benchmarks, bioassays, tissue residue levels, and information from the toxicological literature.

Inorganic and organic chemicals that exceeded ER-M values in a few samples included mercury and 4,4-DDT. Mercury was elevated (5.6 and 7.1 mg/kg) in two soil samples. For total DDT, total chlordanes, total PAHs, and total PCBs, exceedances of the ER-M were based on the use of one-half the detection limit, versus actual detections.

The maximum organic HI of 483 at the Wood Hogger Site (sample location WHSSB015) was based on comparisons to effects range-low (ER-L) values. Dieldrin, at 6.0  $\mu\text{g/kg}$ , contributed 62 percent of the hazard index; the ER-L for dieldrin (0.02  $\mu\text{g/kg}$ ) is conservative, and Long and Morgan (1991) place a low confidence in the ER-L. DDTs, dieldrin, chlordanes, PCBs, and dioxins are ubiquitous and persistent in San Francisco Bay (SFEI 1997) as well as in the Tidal Area.

Selected inorganic chemicals exceeded soil benchmarks for terrestrial invertebrates and may pose a risk to organisms living in direct contact with the soil, particularly in the southwestern corner near the former incinerator. However, the Wood Hogger is a disturbed site with limited ecological relevance. The habitat quality is poor in the southwestern corner of the Wood Hogger due to previous land

development, fill, and industrial activity. Soil tilth and nutrient availability are also poor. Nutrient deficiency in copper and zinc were also indicated in pickleweed tissues that were sampled.

The 1998 field sampling event was implemented in part to address the Navy's concerns that dioxins present at the Wood Hogger Site were being transported into Otter Sluice and taken up by fish. However, the sampling event found that dioxin levels in fish tissues from Otter Sluice did not differ from those caught in San Francisco Bay. Dioxins were below the detection limits in sediments in Otter Sluice.

Based on the food-chain modeling results, all HQ<sub>1</sub> (low dose/high TRV), HQ<sub>3</sub> (high dose/high TRV), and HQ<sub>5</sub> (typical dose/high TRV) values were less than 1.0 using the maximum concentrations of chemicals at the site. There was a potential risk (HQ<sub>2</sub> or HQ<sub>4</sub> greater than 1.0) to birds and mammals from dioxins. However, the model used to assess risk from dioxins was conservative because the model used one-half of the detection limit for PCDDs and PCDFs even if these chemicals were not detected. Evaluation of the food-chain modeling results indicates that the majority of the calculated risks attributable to PCDDs and PCDFs were from locations that were actually below detection limits. If only detected concentrations were considered in the model, little or no risk from dioxins would be indicated. Therefore, dioxin is not considered a risk driver for birds and mammals.

#### **9.4.4 Conclusions and Recommendations**

The results of the HHRA indicate that cancer risk estimates and hazard indices for the site can be attributed primarily to PAHs and dioxins and furans. The highest concentrations of PAHs were detected in the soil samples collected near the Wood Hogger machinery in the southwestern corner of the site. Dioxins and furans were also detected in soil samples collected in the southwestern corner of the site in the vicinity of the former incinerator. The cancer risk estimates for the soil are within the target risk range for the industrial exposure scenario. No remedial action is recommended for the Wood Hogger site to address risk to human health.

Based on the available lines of evidence, there is no significant or immediate risk to ecological receptors at the Wood Hogger Site, and no response action is recommended for the protection of ecological receptors.

The results of the HHRA and QEA both indicate that the site does not pose significant or immediate risk to receptors. Therefore, no further action is warranted at the Wood Hogger Site.

Risk to human health was not evaluated for Otter Sluice because Otter Sluice is not suitable for recreational exposure to humans.

A QEA was conducted for Otter Sluice. A complete description of the risk assessment is presented in Volume II of this report. A summary of the conclusions and recommendations of the QEA for Otter Sluice are presented in this section. Although discussed separately in this RI, Otter Sluice has never been established as an IR site. In addition, Otter Sluice is recommended for no further action under CERCLA. Because of its physical proximity next to the R Area Disposal Site, the ROD for the R Area Disposal Site should incorporate the decision for Otter Sluice.

Sediment, waste extraction test, surface water, tissue, and bioassay samples were collected throughout Otter Sluice as part of the QEA. Chemicals of ecological concern were identified based on the exposure and effects assessment using lines of evidence such as toxicity-based benchmarks, bioassays, tissue residue levels, and information from the toxicological literature.

Inorganic chemicals rarely exceeded the ER-Ms; copper, lead, and zinc exceeded ER-Ms in less than three samples. Six of 45 sediment samples exceeded the ER-M for mercury (0.71 part per million) in Otter Sluice. The maximum mercury concentration in sediments of South Otter Sluice was 18.5 mg/kg. Potential risk to fish and invertebrates exists in that area due to mercury. Tissue residue data collected near these locations showed no significant bioaccumulation of mercury. Generally, risk to higher trophic levels from mercury biomagnification is a cause for concern; however, no significant risk to birds and mammals was indicated by food-chain modeling.

For organic chemicals, exceedances of the ER-M for total PAHs were based on the use of one-half the detection limit, versus actual detections.

In surface water, aluminum, chromium, copper, lead, mercury, nickel, and zinc exceeded AWQCs in at least one sampling quarter. Of the organic chemicals detected in surface water, 4,4-DDT, dieldrin, endrin, heptachlor, total chlordanes, and total PAHs exceeded AWQCs. The exceedance of chlordanes and PAHs, however, was based on one-half the detection limit if these chemicals were not actually detected in the samples.

Chlorinated pesticides, DDTs, PCBs, and dioxins detected in fish and clam tissues were within the range of reported values for fish, bivalves, or both in Suisun Bay or nearby Grizzly Bay. Dioxins were not detected in Otter Sluice sediments.

Based on the food-chain model results, all HQ<sub>1</sub> (low dose/high TRV), HQ<sub>3</sub> (high dose/high TRV), and HQ<sub>5</sub> (typical dose/high TRV) values were less than 1.0 using the maximum concentrations of chemicals at the site. A potential risk (HQ<sub>2</sub> or HQ<sub>4</sub> greater than 1.0) to birds and mammals from mercury was also determined to pose a potential risk to birds and mammals at two locations on the southern border between the Wood Hogger Site and South Otter Sluice. The risk calculated was low (HQ<sub>2</sub> just above 1.0 and HQ<sub>4</sub> less than 2.0 for the rail and heron). It should be noted that the TRV for mercury, which was used to calculate the HQ values, was based on methyl mercury, a highly bioavailable and toxic organic form of mercury. The mercury in the site sediment, however, was measured as total mercury and includes other forms of mercury besides organic. As a result, the HQ values calculated for mercury likely overestimate the actual risk at the site. As another line of evidence, the concentrations of mercury in fish tissue collected from Otter Sluice were evaluated to assess potential bioaccumulation of mercury; the data indicate that the concentrations of mercury in fish tissue were comparable to regional fish tissue data from the RMP (SFEI 1997). Therefore, mercury is not considered to be a risk driver for birds and mammals in the Wood Hogger and Otter Sluice area.

Direct toxicity to aquatic invertebrates was assessed using an amphipod bioassay; all seven samples in Otter Sluice showed no adverse effects on amphipod survival and reburial. The sediments from Otter Sluice were also tested using a sediment-water interface (SWI) test with topsmelt embryo. The two SWI topsmelt tests performed on samples adjacent to the southwestern corner of Otter Sluice had the highest hatching success and were not significantly different than controls. The remaining SWI tests showed toxicity; however, results were inconclusive due to potential confounding factors.

Based on the weight-of-evidence evaluation, there is no significant or immediate risk to ecological receptors in Otter Sluice. No response action is recommended for the protection of ecological receptors at Otter Sluice.

## 9.6

### SUMMARY

Remedial action under CERCLA is recommended to cap the Tidal Area Landfill, and the ROD for the Tidal Area Landfill Site is expected to be signed by the end of 1999. Evaluation of the Tidal Area Landfill Site within the landfill boundary was beyond the scope of this RI.

The land at the perimeter of the Tidal Area Landfill is located within the R Area Disposal Site. No further action is recommended to address this portion of the R Area Disposal Site. Otter Sluice is also recommended for no further action. Otter Sluice has not been established as an IR site, and most of Otter Sluice is located adjacent to the R Area Disposal Site. All other land within the R Area Disposal Site is also recommended for no further action. Because the entire R Area Disposal Site, including lands adjacent to the Tidal Area Landfill and Otter Sluice, does not pose a significant or immediate threat to human or ecological receptors, the entire R Area Disposal Site is recommended for incorporation into a no further action ROD. The Froid and Taylor Roads Site and the Wood Hogger Site are also recommended for no further action. No FS is recommended because all three of these sites are not appropriate for further action.

Decisions for CERCLA sites, such as the three Tidal Area sites, reflect input by all parties involved in the risk assessment process, including the Navy, the EPA, the Cal/EPA (DTSC and RWQCB), the USFWS, the CDFG, the NOAA, and the public. The Navy recommends that the R Area Disposal Site, the Froid and Taylor Roads Site, and the Wood Hogger Site proceed to a single no further action ROD to address these three sites.



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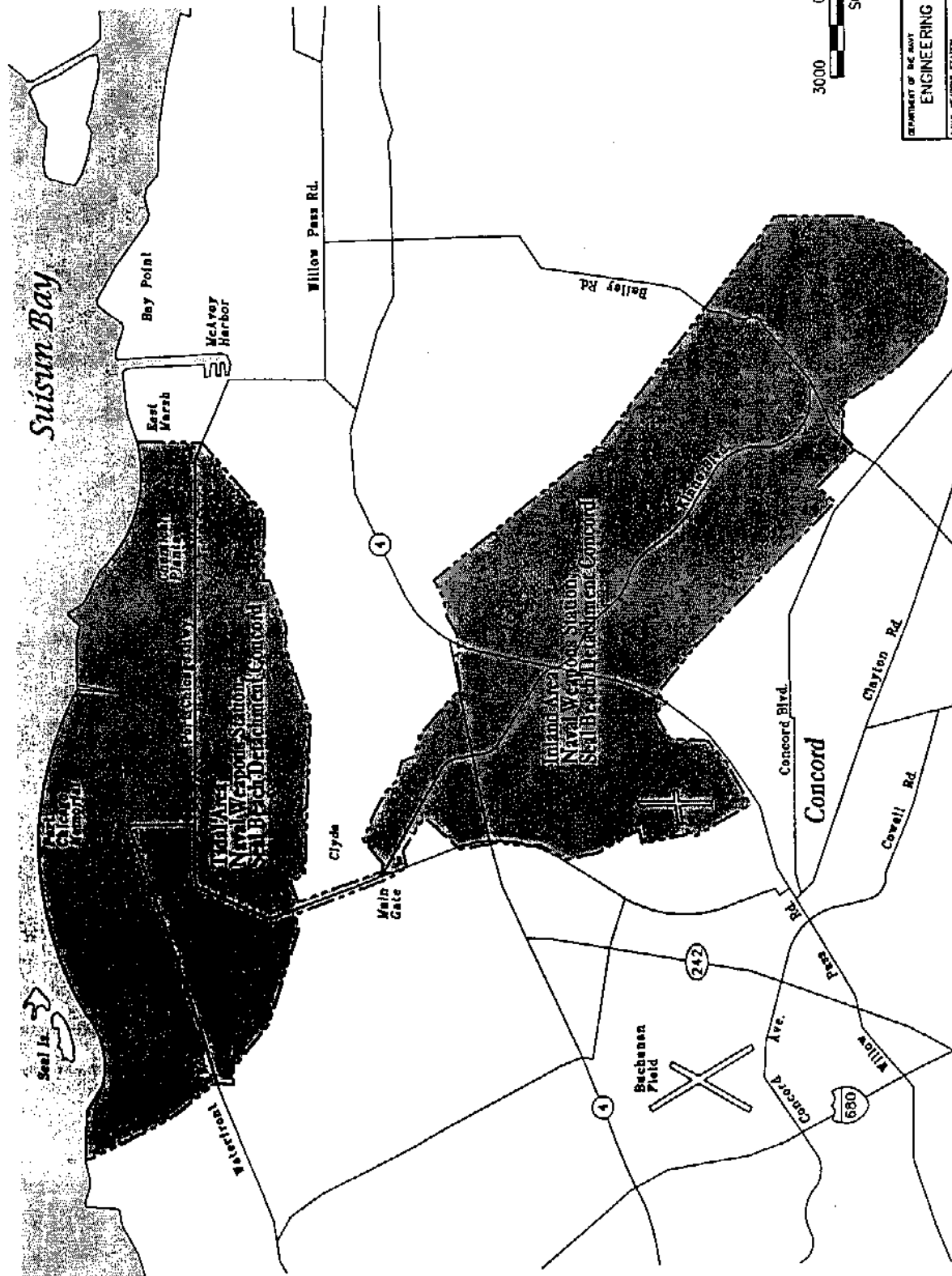
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DEPARTMENT OF THE ARMY  
ENGINEERING FIELD ACTIVITY WEST  
NAVY WEAPONS STATION  
SBD, SBD RETIREMENT  
SAN BRUNO CALIFORNIA  
CONCORD, CALIFORNIA

FIGURE 1-1  
VICINITY OF  
NWS SBD CONCORD

TABLE 3-1

**SUMMARY TABLE OF SAMPLES BY TYPE AND LOCATION  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Site	Number of Locations/ Samples	CTO 281			CTO 283	CTO 033	CTO 217							
		Sediment	Soil	Surface Water	Soil	Soil	Amphipod Tissue	Clam Tissue	Fish Tissue	Sediment	Soil	Surface Water	Pickleweed Tissue	Mouse Tissue
Tidal Area Landfill Site	Locations	0	8	0	0	0	0	0	0	0	0	0	0	0
	Samples	0	24	0	0	0	0	0	0	0	0	0	0	0
R Area Disposal Site	Locations	2	111	17	0	0	0	0	0	3	3	0	0	0
	Samples	2	152	52	0	0	0	0	0	3	3	0	0	0
Froid and Taylor Roads Site	Locations	0	9	2	0	0	1	0	1	0	0	3	2	2
	Samples	0	27	10	0	0	1	0	1	0	0	3	2	3
Wood Hogger Site	Locations	3	71	6	0	11	0	0	0	3	1	0	0	0
	Samples	3	114	25	0	13	0	0	0	3	1	0	0	0
Otter Sluice	Locations	0	0	0	0	0	0	5	5	0	0	9	0	9
	Samples	0	0	0	0	0	0	7	7	0	0	16	0	9
SWMU 37	Locations	0	0	0	12	0	0	0	0	0	0	0	0	0
	Samples	0	0	0	23	0	0	0	0	0	0	0	0	0

Notes:

CTO Contract task order  
SWMU Solid waste management unit

**TABLE 3-2**

**LOCATION OF WATER LEVEL MEASURING POINTS AND  
MONITORING PERIOD FOR TIDAL SURVEY  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD, CONCORD, CALIFORNIA**

Location	Date and Time Period Monitoring		Surface Water Gauge	Groundwater Monitoring Well
	Begin	End		
Suisun Bay	6/23/94 18:35	6/30/94 13:50	SW-0	NA
Otter Sluice	6/23/94 18:35	6/30/94 13:50	SW-1	NA
	6/23/94 18:47	6/30/94 14:17	SW-2	NA
	6/24/94 10:20	6/30/94 12:35	SW-5	NA
	6/27/94 11:50	6/30/94 12:05	SW-7	NA
	6/27/94 09:50	6/30/94 11:50	SW-8	NA
Tidal Area Landfill Site	6/24/94 08:20	6/30/94 13:20	NA	TLW-2
R Area Disposal Site	6/23/94 18:47	6/30/94 14:17	SW-3	RDW-2 RDW-3 RDW-4 RDW-5
Froid and Taylor Roads Site	6/24/94 11:35	6/30/94 2:50	SW-4	FTW-3
Wood Hogger Site	6/24/94 10:20	6/30/94 12:35	SW-6	NA
	6/27/94 08:20	6/30/94 11:20	NA	WHW-2
	6/27/94 10:50	6/30/94 12:20	NA	WHW-3

Note:

NA      Not applicable

TABLE 3-3

**SAMPLE CONTAINER, HOLDING TIMES, AND PRESERVATIVE REQUIREMENTS FOR SOIL SAMPLES**  
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD, CONCORD, CALIFORNIA**

Parameter	Method Number <sup>a</sup>	Sample Container	Preservative	Holding Time <sup>b</sup>
<b>Organic Analyses</b>				
VOCs	CLP RAS <sup>c</sup>	6-in sleeve <sup>d</sup> , no headspace	Cool, 4 °C	14 days
SVOCs	CLP RAS <sup>c</sup>	6-in sleeve <sup>d</sup>	Cool, 4 °C	14 days/40 days
Organochlorine Pesticides and PCBs	CLP RAS <sup>c</sup>	6-in sleeve <sup>d</sup>	Cool, 4 °C	14 days/40 days
Explosives	EPA 8330	6-in sleeve <sup>d</sup>	Cool, 4 °C	7 days/40 days
TPH-e	8015/CLP SAS <sup>c</sup>	6-in sleeve <sup>d</sup>	Cool, 4 °C	14 days/40 days
Dioxins and Furans	8280/CLP SAS <sup>c</sup>	6-in sleeve <sup>d</sup>	Cool, 4 °C	30 days/45 days <sup>f</sup>
<b>Inorganic/Physical Analyses</b>				
Metals	CLP RAS <sup>c</sup>	6-in sleeve <sup>d</sup>	Cool, 4 °C	Hg 28 days; others, 6 months
Hexavalent Chromium	EPA 7196	6-in sleeve <sup>d</sup>	Cool, 4 °C	24 hours <sup>g</sup>
TOC	Mod. ASTM D2974-87	6-in sleeve <sup>d</sup>	Cool, 4 °C	10 days
Sulfide	EPA 9030	6-in sleeve <sup>d</sup>	Cool, 4 °C	7 days
Grain Size	ASTM D422-63	6-in sleeve <sup>d</sup>	NA	NA
Soil Bulk Density	ASTM D2937	6-in sleeve <sup>d</sup>	NA	NA
Soil Porosity	Calculated <sup>h</sup>	6-in sleeve <sup>d</sup>	NA	NA
Moisture Content	ASTM D2216	6-in sleeve <sup>d</sup>	Cool, 4 °C	2 weeks <sup>i</sup>



TABLE 3-3 (Continued)

**SAMPLE CONTAINER, HOLDING TIMES, AND PRESERVATIVE REQUIREMENTS FOR SOIL SAMPLES**  
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD, CONCORD, CALIFORNIA**

Parameter	Method Number <sup>a</sup>	Sample Container	Preservative	Holding Time <sup>b</sup>
<b>Inorganic/Physical Analyses (Continued)</b>				
Grain Size Analysis	ASTM D422	6-in sleeve <sup>d</sup>	NA	NA
Permeability	ASTM D2434	6-in sleeve <sup>d</sup>	NA	NA
pH	EPA 9045	6-in sleeve <sup>d</sup>	NA	Not promulgated

## Notes:

- ASTM American Society for Testing Materials  
 CLP Contract laboratory program  
 EPA U.S. Environmental Protection Agency  
 Hg Mercury  
 NA Not applicable
- <sup>a</sup> Complete method references are presented in Section 8.0, Table 8-1 of quality assurance project plan (QAPP).  
<sup>b</sup> # days/# days refers to the maximum number of days from sampling to extraction/the maximum number of days from extraction to analysis.  
<sup>c</sup> Routine analytical services:  
 EPA. 1993c. "CLP Statement of Work for Inorganics Analyses." ILM03.0  
 EPA. 1993d. "CLP Statement of Work for Organic Analyses." OLM02.1  
<sup>d</sup> Surface samples were collected in stainless steel sleeves, and subsurface samples were collected in acetate sleeves. Multiple parameters may be analyzed from a single sleeve.  
<sup>e</sup> Special analytical services; low resolution dioxin/furans method  
<sup>f</sup> 45 days from collection  
<sup>g</sup> A 24-hour holding time is applicable for water matrices but has not been determined for soil.  
<sup>h</sup> Soil porosity is calculated using measured moisture content and soil density values.  
<sup>i</sup> Recommended, but not a required holding time
- PCB Polychlorinated biphenyl  
 RAS Routine analytical service  
 SVOC Semivolatile organic compound  
 TPH-e Total petroleum hydrocarbons-extractable  
 VOC Volatile organic compound

TABLE 3-4

**SAMPLE CONTAINER, HOLDING TIMES, AND PRESERVATIVE REQUIREMENTS FOR WATER SAMPLES**  
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD, CONCORD, CALIFORNIA**

Parameter	Method <sup>a</sup>	Sample Container <sup>b</sup>	Sample Volume	Preservatives	Holding Time <sup>c</sup>
<b>Organic Analyses</b>					
VOCs	CLP SAS <sup>d</sup>	V	160 mL, no headspace	HCl to pH < 2 Cool, 4 °C	14 days
SVOCs	CLP RAS <sup>e</sup>	G	2L	Cool, 4 °C	7 days/40 days
Organochlorine Pesticides and PCBs	CLP RAS	G	2L	Cool, 4 °C	7 days/40 days
TPH-d	CLP SAS	G	2L	Cool, 4 °C	7 days/40 days
Explosives	EPA 8330	G	2L	Cool, 4 °C	7 days/40 days
<b>Inorganic/Physical Analyses</b>					
Metals	CLP RAS	P	1L	Filtered <sup>f</sup> and unfiltered, HNO <sub>3</sub> to pH < 2	Hg, 28 days; others, 6 months
Hexavalent Chromium	EPA 218.4	P	500 mL	Cool, 4 °C	24 hours
Total Organic Carbon	EPA 415.1	G	125 mL	HCl to pH < 2 Cool, 4 °C	28 days
Total Suspended Solids	EPA 160.2	P	100 mL	Cool, 4 °C	7 days
Total Dissolved Solids	EPA 160.1	P	250 mL	Cool, 4 °C	7 days

## Notes:

CLP Contract laboratory program  
EPA U.S. Environmental Protection Agency  
L Liter  
Hg Mercury  
HCl Hydrochloric acid

**TABLE 3-4 (Continued)**

**SAMPLE CONTAINER, HOLDING TIMES, AND PRESERVATIVE REQUIREMENTS FOR WATER SAMPLES  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD, CONCORD, CALIFORNIA**

Notes (Continued):	
mL	Milliliter
PCB	Polychlorinated biphenyl
RAS	Routine analytical service
SAS	Special analytical service
SVOC	Semivolatile organic compound
VOC	Volatile organic compound
TPH-d	Total petroleum hydrocarbons as diesel
a	Complete method references are presented in Section 8.0, Table 8-1 of the quality assurance project plan (QAPP).
b	Container types: G - Amber glass with Teflon-lined lid, sized according to sample volume
	P - Polyethylene container sized according to sample volume
	V - VOC (volatile organic analysis) vial with Teflon-lined septum, 40-mL size
c	# days/# days refers to the maximum number of days from sampling to extraction/the maximum number of days from extraction to analysis.
d	Special analytical services
e	Routine analytical services:
	EPA, 1993d. "CLP Statement of Work for Inorganic Analyses." ILM03.0
	EPA, 1993d. "CLP Statement of Work for Organic Analysis." ILM02.1
f	Filtered using 5-micron filter

TABLE 3-5

**ANALYTICAL METHODS FOR SURFACE WATER SAMPLES  
TIDAL AREA REMEDIAL INVESTIGATION REPORT  
NWS SBD, CONCORD, CALIFORNIA**

Parameter	Method Number <sup>a</sup>	Reference <sup>b</sup>	Analyte List	Technique
<b>Organic Analyses:</b>				
Volatile organic compounds (VOC)	CLP SAS	EPA 1993e	TCL + 10 TIC	GC/MS
Semivolatle organic compounds (SVOC)	CLP RAS	EPA 1993d	TCL + 20 TIC	GC/MS
Organochlorine pesticides and polychlorinated biphenyls (PCB)	CLP RAS	EPA 1993d	TCL	GC
Explosives	EPA 8330	EPA 1990		
<b>Inorganic/Physical Analyses:</b>				
Metals	CLP RAS	EPA 1993d	TAL	ICP & AA
Total organic carbon	EPA 415.1	EPA 1983		Combustion or Oxidation
Total suspended solids	EPA 160.2	EPA 1983		Gravimetric
Total dissolved solids	EPA 160.1	EPA 1983		Gravimetric

## Notes:

AA Atomic adsorption spectroscopy  
 CLP Contract laboratory program  
 EPA U.S. Environmental Protection Agency  
 GC Gas chromatography  
 ICP Inductively coupled plasma emission spectroscopy  
 MS Mass spectrometry

RAS Routine analytical services  
 SAS Special analytical services  
 TAL Target analyte list  
 TCL Target compound list  
 TIC Tentatively identified compound

<sup>a</sup> Other EPA and U.S. Department of the Navy (Navy)-approved methods may be selected with approval from the Navy remedial project manager (RPM). All method changes will be documented in writing.

<sup>b</sup> EPA. 1983. "Methods for Chemical Analysis of Water and Wastes." March.

EPA. 1990. "SW-846, update."

EPA. 1993d. "EPA CLP Statement of Work for Organic Analyses."

EPA. 1993e. "CLP Special Analytical Services for Organic Analyses."



**TABLE 3-6**  
**ANALYTICAL METHODS FOR SOIL SAMPLES**  
**TIDAL AREA REMEDIAL INVESTIGATION REPORT**  
**NAVAL WEAPONS STATION, CONCORD CALIFORNIA**

Parameter	Method Number <sup>a</sup>	Reference <sup>b</sup>	Analyte List	Technique
<b>Organic Analyses:</b>				
Volatile organic compounds	CLP RAS	EPA 1990c, 1990d	TCL + 10 TIC	GC/MS
Semivolatile organic compounds	CLP RAS	EPA 1990c, 1990d	TCL + 20 TIC	GC/MS
Organochlorine pesticides and polychlorinated biphenyls	CLP RAS	EPA 1990c, 1990d	TCL	GC
Explosives	EPA 8330	EPA 1986		HPLC
Dioxins and furans	8280/CLP SAS	EPA 1989c		GC/MS
TPH-d	EPA 8015/3550	EPA 1986		GC
<b>Inorganic/Physical Analyses:</b>				
Metals	CLP RAS	EPA 1990c, 1990d	TAL	ICP & AA
Hexavalent chromium	EPA 7196	EPA 1986		Furnace/Flame or Colorimetric
Sulfide	EPA 9030	EPA 1986		
Total organic carbon	Modified ASTM D2974-87	ASTM		
Grain size analysis	ASTM D422-63	ASTM	ASTM	
Soil porosity	Calculated	EPA 1986		
Permeability	ASTM D2434	ASTM	ASTM	

TABLE 3-6 (Continued)

**ANALYTICAL METHODS FOR SOIL SAMPLES  
TIDAL AREA REMEDIAL INVESTIGATION REPORT  
NAVAL WEAPONS STATION, CONCORD CALIFORNIA**

Parameter	Method Number <sup>a</sup>	Reference <sup>b</sup>	Analyte List	Technique
<b>Inorganic/Physical Analyses (Continued):</b>				
Moisture content and soil bulk density	D2937	ASTM		
pH	EPA 9045	EPA 1986		

## Notes:

- AA Atomic adsorption spectroscopy  
 ASTM American Society for Testing and Materials  
 CLP Contract laboratory program  
 EPA U.S. Environmental Protection Agency  
 GC Gas chromatography  
 HPLC High performance liquid chromatography  
 ICP Inductively coupled plasma emission spectroscopy
- <sup>a</sup> Other EPA and U.S. Department of the Navy (Navy)-approved methods may be selected with approval from the Navy remedial project manager. All method changes will be documented in writing.
- <sup>b</sup> EPA. 1986. *Test Methods for Evaluating Solid Waste*. 3rd Edition.  
 EPA. 1989c. "CLP Special Analytical Services for Organic Analyses."  
 EPA. 1990c. "CLP Statement of Work for Organic Analyses."  
 EPA. 1990d. "CLP Statement of Work for Inorganic Analyses."
- <sup>c</sup> Soil porosity is calculated using measured moisture content and soil density values.
- MS Mass spectrometry  
 RAS Routine analytical services  
 SAS Special analytical services  
 TAL Target analyte list  
 TCL Target compound list  
 TIC Tentatively identified compound  
 TPH-d Total petroleum hydrocarbons as diesel

TABLE 4-1

**LOCATION-SPECIFIC ARARs, TIDAL AREA LANDFILL  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Location Concerns	Purpose/Requirement	Applicability to Remedial Action	Citation <sup>1</sup>	Preliminary Determination
Endangered Species	Conserve endangered or threatened species and critical habitats.	Both endangered and threatened species are known to reside within or near the Tidal Area.	16 USC 1531, et seq.	Appropriate and Relevant
Protection of California Endangered Species	Prohibits the taking of any endangered or threatened species.	Both endangered and threatened species are known to reside within or near the Tidal Area. It is not known whether such species reside at the landfill.	FGC Section 2080	Applicable
Protection of Wildlife Species	Prohibits the taking or possession of birds and mammals by trapping, netting, or with a poisonous substance.	Although the taking of such species is not anticipated during landfill capping remedies, this ARAR has been included to protect wildlife species in the vicinity of the landfill.	FGC 3005(a)	Applicable
Protection of Birds	Prohibits the taking of protected birds such as the California clapper rail.	Although the taking of such species is not anticipated during the landfill capping remedies, this ARAR has been included to guard against the taking of protected birds which may live in the vicinity of the landfill.	FGC Section 3511	Applicable
Protection of Aquatic Habitat and Species	Prohibits the deposition of toxic materials into state waters that would have a deleterious effect on species or habitat.	Although landfill leachate formation has not been detected and proposed capping remedies would further limit leachate formation, this ARAR is included to protect aquatic habitat and species. The landfill is located within a low elevation marsh and groundwater elevations are typically at or below sea level.	Substantive provisions of FGC Section 5650	Applicable
Coastal Zone	Conduct activities within a coastal zone consistent, to the maximum extent practicable, with the enforceable policies of approved state management programs within San Francisco Bay. The state management program consists of the McAteer-Petris Act and the San Francisco Bay Plan.	The landfill is located approximately 2,000 feet south of Suisun Bay and is considered to be within a coastal zone.	16 USC Section 1456(c)(1)(A); CCR Section 66600, et seq.	Applicable



**TABLE 4-1 (Continued)**

**LOCATION-SPECIFIC ARARs, TIDAL AREA LANDFILL  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Notes:

ARAR

Applicable or relevant and appropriate requirement

CCR

California Code of Regulations

FGC

California Fish and Game Code

USC

United States Code

Only the substantive requirements of the cited provisions are considered ARARs. To the extent the cited provisions contain administrative or procedural requirements, they are not ARARs.

1

TABLE 4-2

**ACTION-SPECIFIC ARARS, TIDAL AREA LANDFILL  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Action	Regulatory Program	Purpose/Requirement	Applicability to Remedial Action	Citation <sup>1</sup>	Preliminary Determination
Landfill Closure with Native Soil Cap	Title 27 California Integrated Waste Management Board; Title 27 State Water Resources Control Board	State regulations for waste management units contain requirements for closing landfills with an engineered alternative consisting of a native soil cap.	The substantive provisions of 27 CCR will apply to closure of the Site 1 landfill because it is a municipal solid waste landfill unit.	27 CCR 21140 (a)(b), 21142(a), 21145(a), 21150(a) and (c); 27 CCR 20950 (a)(2),(b),(d),(e); 27 CCR 20080; 40 CFR 258.60 (b)	Applicable
Capping Adjacent to Wetland Area	Clean Water Act Sections 404 and 404(b)(1); EPA Guidelines, 40 CFR Part 230	Prohibits unauthorized discharge of dredged or fill material into waters of the United States.	Substantive requirements are applicable to placement of dredged sediments or other capping material in wetlands or navigable waters.	33 USC 1341, 1344	Applicable
Landfill Post-Closure Care	Title 27 State Water Resources Control Board	State post-closure standards establish general and landfill-specific requirements for post-closure at solid waste landfills.	Post-closure requirements in 27 CCR are applicable for the Tidal Area Landfill since landfill closure activities including capping are proposed.	27 CCR 21090 (c)(1)(3)(4)(5)	Applicable
Groundwater Monitoring	Title 27 State Water Resources Control Board	Closure and post-closure standards for permitted landfills require groundwater monitoring programs following closure. Groundwater shall be monitored for 5 years for exceedances of established water quality protection standards criteria.	The substantive provisions of 27 CCR Sections 20415 and 20420 apply to the landfill because it operated prior to November 27, 1984 (existing unit).	27 CCR 20415 (b)(1)(B) and (e); 27 CCR 20420	Applicable

**TABLE 4-2 (Continued)**

**ACTION-SPECIFIC ARARs, TIDAL AREA LANDFILL  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Action	Regulatory Program	Purpose/Requirement	Applicability to Remedial Action	Citation <sup>1</sup>	Preliminary Determination
Methane Gas Emissions Monitoring	Title 27 California Integrated Waste Management Board	Concentrations of methane gas should not exceed the lower explosive limit for methane, or 5% by volume in air, at the facility boundary. These requirements also include standards for constructing a monitoring well network, parameters, and frequency of monitoring.	Monitoring requirements in 27 CCR are applicable as postclosure activities following capping at the Tidal Area Landfill.	27 CCR Sections 20918, 20921, 20923, 20925, 20932, 20933, 200919.5; 20937	Applicable

**Notes:**

**ARAR** Applicable or relevant and appropriate requirement

**CCR** California Code of Regulations

**CFR** Code of Federal Regulations

**1** Only the substantive requirements of the cited provisions are considered ARARs. To the extent the cited provisions contain administrative or procedural requirements, they are not ARARs.

TABLE 4-3

**LOCATION-SPECIFIC TBCs, TIDAL AREA LANDFILL  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Location Concerns	Purpose/Requirement	Applicability to Remedial Action	Citation <sup>1</sup>	Preliminary Determination
Floodplain Protection	Requires federal agencies to evaluate potential effects of action taken in floodplains to avoid, to the extent possible, adverse effects of development in floodplains.	The landfill is located within a low elevation marsh adjacent to Suisun Bay. Ground elevations along the perimeter of the landfill are typically at or below sea level.	Executive Order 11988	TBC
Wetland Protection	Requires federal agencies to avoid, to the extent possible, adverse impacts associated with destruction of wetlands and to avoid construction in wetlands if a practical alternative exists.	The landfill has been classified as an upland area, but is directly bordered by jurisdictional wetlands, which may be impacted by remedial activities.	Executive Order 11990	TBC

## Notes:

ARAR      Applicable or relevant and appropriate requirement

TBC      To be considered regulations

1      Only the substantive requirements of the cited provisions are considered ARARs. To the extent the cited provisions contain administrative or procedural requirements, they are not ARARs.



TABLE 4-4

**CHEMICAL-SPECIFIC ARARs FOR SITES 2, 9, AND 11  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Citation	Requirement Description	ARAR Type	Tidal Area Sites Affected	Comments
Porter-Cologne Water Quality Control Act Water Code Section 13140 and 13240 San Francisco Bay Region Basin Plan, June 1995	The Porter-Cologne Water Quality Control Act establishes the state's authority to formulate plans and to designate the beneficial uses of the state waters and to establish water quality objectives in the form of narrative and numeric standards. The San Francisco Bay Region Basin Plan, dated June 1995, designates the beneficial uses of surface waters in and near Tidal Area sites and establishes water quality objectives for the surface waters.	Chemical-specific for surface water	Applicable to Sites 2, 9, and 11	The designated beneficial use and water quality objectives establish the surface water quality standards that must be achieved if remedial action is required for surface water affected by all of the Tidal Area sites. The water quality objectives will also be used to establish action-specific limits for any point source discharges that are necessary to implement the selected remedies for the sites.
National Ambient Water Quality Criteria (NAWQC) 33 USC Section 1314(a)	Federal water quality criteria are nonenforceable guidance established by EPA for evaluating toxic effects on human health and aquatic organisms; they are considered by the states in setting water quality standards for surface water.	Chemical-specific	Potentially Relevant and Appropriate to Sites 2, 9, and 11	Under CERCLA Section 121(d)(2)(A), surface water quality criteria may be considered relevant and appropriate to CERCLA response actions.

## Notes:

ARAR    Applicable or relevant and appropriate requirements  
CERCLA    Comprehensive Environmental Response, Compensation, and Liability Act  
EPA    U.S. Environmental Protection Agency  
USC    United States Code



TABLE 5-1

**TIDAL INFLUENCE SURVEY RESULTS  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Monitoring Location	Distance from Otter Sluice (feet)	Range of Water Level Variation (feet)	Shows Tidal Influence	Shows Diurnal Variation	Shows Long-Term Decline in Water Level
<b>Surface Water:</b>					
SW-0 Suisun Bay	0	5.67	✓		
SW-1 Otter Sluice (R Area)	0	2.45	✓		
SW-2 Otter Sluice (R Area)	0	2.40	✓		
SW-3 R Area wetlands	80	0.26	✓		✓
SW-4 Froid and Taylor Roads slough	1,300	0.15		✓	✓
SW-5 Otter Sluice (Wood Hogger)	0	1.80	✓		
SW-6 Wood Hogger wetlands	100	0.54		✓	✓
SW-7 Otter Sluice (Wood Hogger)	0	0.97	✓		
SW-8 Otter Sluice (Wood Hogger)	0	0.56	✓		
<b>Groundwater:</b>					
TLW-2 Tidal Area Landfill	1,100	0.03			
RDW-2 R Area Disposal	60	1.58		✓	✓
RDW-3 R Area Disposal	55	0.30	✓		
RDW-4 R Area Disposal	80	0.13			✓
RDW-5 R Area Disposal	460	0.33		✓	✓
FTW-3 Froid and Taylor Roads	1,300	0.17			
WHW-2 Wood Hogger	550	0.18			
WHW-3 Wood Hogger	60	0.67	✓		

**Notes:**

Data recorded in monitoring well WHW-3 appear questionable. A spike appears in the data that cannot be attributed to tidal effects. The spike has been disregarded in the quantitative assessment.





TABLE 5-2

**SUMMARY OF GROUNDWATER ELEVATIONS, JULY 1995 THROUGH APRIL 1996  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Well	Piezometric Surface Elevation (feet above msl)				Water Level Response Pattern
	July 1995	October 1995	January 1996	April 1996	
TLSMW001	-0.77	-3.18	0.22	-0.15	SCS
TLSMW002	-0.36	-1.71	-0.83	-0.08	SCL
TLSMW003	-1.19	-1.78	0.28	-0.42	SCS
TLSMW004	1.78	1.03	2.62	2.13	SCS
TLSMW005	1.77	0.83	2.77	2.12	SCS
TLSMW006	-0.02	-0.53	0.78	0.35	SCS
TLSMW007	-0.47	-2.20	0.04	-0.15	SCS
RADMW001	-0.07	-3.15	1.55	0.05	SCS
RADMW002	0.64	0.30	0.24	0.36	MOS
RADMW003	1.14	0.56	0.59	0.39	MOS
RADMW004	1.38	1.01	3.14	2.06	SCS
RADMW005	-0.03	-2.03	2.10	1.88	SCS
RADMW006	-0.28	-1.99	-0.48	0.05	SCL
RADMW007	-0.61	-2.08	-0.45	-0.17	SCL
RADPZ001	NA	-1.96	-0.52	-0.43	SCL
RADPZ002	NA	-3.85	-1.38	-1.83	SCS
FTSMW001	0.96	-0.85	1.89	1.04	SCS
FTSMW002	1.00	-1.27	-0.60	0.23	SCL
FTSMW003	2.00	0.55	2.29	2.42	SCL
FTSMW004	0.80	0.31	1.94	1.40	SCS
FTSMW005	1.46	0.16	1.80	1.72	SCS
WHSMW001	1.52	-0.04	-1.04	0.75	SCL
WHSMW002	0.67	-1.01	1.40	0.81	SCL
WHSMW003	NA	1.00	1.40	0.69	MOS
WHSMW004	1.62	0.76	1.06	0.57	MOS

## Notes:

- msl Mean sea level
- MOS Exhibits a moderating effect caused by hydraulic connection to Otter Sluice.
- NA Not measured
- SCL Exhibits a seasonal cycle reflective of rainfall patterns, with short lag time.
- SCS Exhibits a seasonal cycle reflective of rainfall patterns, with a moderate to long lag time.



**TABLE 5-3**

**SUMMARY OF SURFACE WATER ELEVATIONS, JULY 1995 THROUGH APRIL 1996  
TIDAL AREA SITES REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Surface Water Location	Surface Water Type	Surface Water Elevation (feet above msl)				Water Level Response Pattern
		July 1995	October 1995	January 1996	April 1996	
RADSG001	Otter Sluice	1.20	2.32	1.99	0.32	DTL
RADSG002	Otter Sluice	1.29	1.17	1.67	-0.16	DTL
RADSG003	Otter Sluice	1.09	1.07	1.53	-0.52	DTL
RADSG004	Wetland/Marsh	-0.27	-0.72	0.53	0.03	SCS
RADSG007	Natural Slough	-0.46	Dry	-0.62	-1.37	SCL
RADSG008	Wetland/Marsh	Dry	Dry	0.32	Dry	SCS
FTSSG010	Ephemeral Pool	0.47	-2.16	2.14	1.41	SCS
WHSSG005	Otter Sluice	1.10	1.14	1.52	-0.19	DTL
WHSSG006	Otter Sluice Tributary	1.70	1.22	1.41	NA	DTL
WHSSG009	Otter Sluice Tributary	1.78	1.18	1.43	-1.94	DTL

Notes:

- DTL Exhibits a direct tidal influence
- msl Mean sea level
- NA Not measured
- SCL Exhibits a seasonal cycle reflective of rainfall patterns, with a moderate to long lag time
- SCS Exhibits a seasonal cycle reflective of rainfall patterns, with a short lag time



**TABLE 6-1**  
**NUMBER OF LOCATIONS BY SITE AND MATRIX**  
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD CONCORD, CALIFORNIA**

Soil/Sediment <sup>a</sup>	1995		1998	
	Soil/Sediment <sup>a</sup>	Surface Water	Soil/Sediment <sup>a</sup>	Surface Water
Froid & Taylor Roads	9	2	5	3
Otter Sluice	5	6	9	9
R Area Disposal	110	13	0	0
Tidal Area Landfill	8	0	0	0
SWMU 37	18	1	1	0
Wood Hogger	68	2	9	0

Notes:

SMWU Solid waste management unit

<sup>a</sup> This table represents the number of locations that were sampled, not the actual number of samples analyzed (many locations were analyzed at multiple depths)



TABLE 6-2

ANALYSES PERFORMED ON 1998 RI AND QEA SAMPLES  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA

Matrix	Sample Location	Inorganics		Organics				Other parameters				Biological Tests	
		Metals	SVOC	Pesticides/ PCBs	Chlordane	Low Level Pesticides/ PCBs	Dioxins	TOC	pH	SEM/AVS	Grain Size	Amphipod Bioassay	Topsmelt Bioassay
Soil (0-0.5 ft.)	Site 9 - Froid and Taylor Roads Site												
	FTSSB100	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
	FTSSB101	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
	Site 11 - Wood Hogger												
	WHSSB009	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB010	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB016	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB008	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB017	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB019	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSS007	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB023	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	WHSSB018	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	Soil Sample Total:	0	0	0	2	0	9	0	0	0	0	0	0
Sediment (0-0.5ft.)	Site 9 - Froid and Taylor Roads Site												
	FTSSL102	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	FTSSL103	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	FTSSL104	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Otter Sluice												
	OSLSL001	1	1	NA	NA	1	NA	1	1	1	1	1	1
	OSLSL002	1	1	NA	NA	1	NA	1	1	1	1	1	1
	OSLSL003	1	1	NA	NA	1	NA	1	1	1	1	1	1
	OSLSL004	1	1	NA	NA	1	NA	1	1	1	1	1	1
	OSLSL005	1	1	NA	NA	1	1	1	1	1	1	1	1
	OSLSL006	1	1	NA	NA	1	1	1	1	1	1	1	1
	OSLSL007	1	1	NA	NA	1	1	1	1	1	1	1	1
	OSLSL008	1	1	NA	NA	1	1	1	1	1	1	NA	NA
	OSLSL009	1	1	NA	NA	1	NA	1	1	1	1	NA	NA
	Sediment Sample Total:	12	12	3	0	9	4	9	9	9	9	7	7
	Site 9 - Froid and Taylor Roads Site												
	FTSSL102	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	FTSSL103	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	FTSSL104	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	Otter Sluice												
	OSLSL001	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL002	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL003	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL004	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL005	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL006	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL007	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL008	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	OSLSL009	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Surface Water Sample Total:	12	12	12	0	0	0	0	0	0	0	0	0



TABLE 6-2

ANALYSES PERFORMED ON 1998 RI AND QEA SAMPLES  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA

Matrix	Sample Location	Inorganics		Organics					Other parameters				Biological Tests				
		Metals	SVOC	Pesticides/ PCBs	Chlordane	Pesticides/ PCBs	Low Level Pesticides/ PCBs	Dioxins	TOC	pH	SEM/AVS	Grain Size	Amphipod Bioassay	Topsmelt Bioassay			
Fish Tissue	Site 9 - Froid and Taylor Roads Site																
	FTST1105	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
	Other Sluice																
	OSLSL002	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA			
	OSLSL004	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA			
	OSLSL005	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA			
	OSLSL006	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA			
	OSLSL007	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA			
	Fish Tissue Sample Total:		6	0	1	0	5	2	0	0	0	0	0	0			
	Clam Tissue	Other Sluice															
OSLSL002		1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA			
OSLSL004		1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA			
OSLSL005		1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA			
OSLSL006		1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA			
OSLSL007		1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA			
Clam Tissue Sample Total:		5	0	0	0	5	2	0	0	0	0	0	0				
Amphipod Tissue		Site 9 - Froid and Taylor Roads Site															
		FTST1105	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
		Amphipod Tissue Sample Total:		1		1											
	Pickleweed Tissue	Site 2 - R Area Disposal															
		RADTI501	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
		RADTI502	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
		RADTI503	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
		Site 11 - Wood Hogger															
		WHST1509	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
		Pickleweed Tissue Sample Total:		4	0	0	0	0	0	0	0	0	0	0	0		
Rodent Tissue		Site 2 - R Area Disposal															
		RAC1 (composite)	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA		
		RAC2 (composite)	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA		
	RAC3 (composite)	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA			
	Site 11 - Wood Hogger																
	WHC1 (composite)	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA			
	WHC2 (composite)	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA			
	WHC3 (composite)	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA			
	Rodent Tissue Sample Total:		6	0	0	0	6	3	0	0	0	0	0	0			

Notes:

- NA Not analyzed
- SEM/AVS Simultaneously extractable metals/acid volatile sulfide
- SVOC Semivolatile organic compound
- TOC Total organic carbon

Table 6-3

## Tidal Area Landfill (Site 1)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria			
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRG	PRG Value	Ambient Value
SEMIVOLATILES	PHENOL	UG/KG	450	11,000	1,800	940	8/16	0	33,000,000	*
TOTAL METALS	ALUMINUM	MG/KG	4,370	29,400	18,600	16,800	24/24	0	75,000	2
	ANTIMONY	MG/KG	1.2	3.1	1.4	1.3	5/17	0	30.0	2
	ARSENIC	MG/KG	2.9	57.6	14.6	11.6	24/24	24	0.38	3
	BARIUM	MG/KG	26.0	436	105	82.0	24/24	0	5,200	0
	BERYLLIUM	MG/KG	0.15	0.56	0.079	0.040	3/24	0	150	2
	CADMIUM	MG/KG	0.74	5.8	0.67	0.12	5/24	0	9.0	4
	CALCIUM	MG/KG	2,840	13,100	6,300	5,860	24/24	*	*	*
	CHROMIUM	MG/KG	1.8	92.5	53.8	43.1	23/24	0	210	5
	COBALT	MG/KG	5.2	33.5	15.6	13.7	24/24	0	3,300	0
	COPPER	MG/KG	17.8	264	49.7	38.6	24/24	0	2,800	3
	IRON	MG/KG	8,110	50,000	26,200	23,600	24/24	12	22,000	0
	LEAD	MG/KG	5.3	156	31.0	15.6	22/24	2	130	2
	MAGNESIUM	MG/KG	3,920	18,700	12,800	12,200	24/24	*	*	*
	MANGANESE	MG/KG	75.1	1,000	348	290	24/24	0	3,100	0
	MERCURY	MG/KG	0.090	6.48	0.12	0.098	6/24	0	22.0	2
	MOLYBDENUM	MG/KG	1.5	4.2	2.1	1.3	7/24	0	370	0
	NICKEL	MG/KG	24.7	131	74.0	68.1	24/24	0	150	1
	POTASSIUM	MG/KG	1,790	7,320	4,770	4,530	24/24	*	*	*
	SILVER	MG/KG	1.2	1.2	0.24	0.19	1/24	0	370	*
	SODIUM	MG/KG	4,520	64,600	26,700	19,800	24/24	*	*	*
	THALLIUM	MG/KG	1.2	2.2	0.74	0.64	3/24	0	5.2	0
										2.2

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-3

## Tidal Area Landfill (Site I)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria					
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRC Value	PRC Value	Ambient Value	
TOTAL METALS	VANADIUM	MG/KG	29.6	108	69.9	67.3	24/24	0	520	2	96.0
	ZINC	MG/KG	45.4	743	144	109	23/24	0	22,000	2	264
VOLATILES	2-BUTANONE	UG/KG	390	390	58	29	1/15	0	6,900,000	*	*
	ACETONE	UG/KG	240	580	210	130	2/15	0	1,400,000	*	*
	CARBON DISULFIDE	UG/KG	10	120	35	24	7/15	0	350,000	*	*
	CHLOROMETHANE	UG/KG	27	46	21	19	3/15	0	1,200	*	*
LOW LEVEL PESTICIDES AND PCBs	2,4'-DDD	UG/KG	0.7	12	3	0.9	5/8	*	*	*	*
	2,4'-DDE	UG/KG	0.6	0.9	0.3	0.2	2/8	*	*	*	*
	2,4'-DDT	UG/KG	1	1	0.2	0.2	1/8	*	*	*	*
	4,4'-DDD	UG/KG	2	27	5	1	5/8	0	2,400	*	*
	4,4'-DDE	UG/KG	2	6	2	0.9	5/8	0	1,700	*	*
	4,4'-DDT	UG/KG	0.7	2	0.7	0.4	4/8	0	1,700	*	*
	ALDRIN	UG/KG	1	2	0.5	0.2	2/8	0	25	*	*
	ALPHA-CHLORDANE	UG/KG	2	5	2	0.9	5/8	0	1,600	*	*
	DIELDRIN	UG/KG	0.5	2	0.6	0.3	3/8	0	28	*	*
	HEPTACHLOR	UG/KG	0.6	0.8	0.3	0.2	2/8	0	990	*	*
	HEXACHLOROBENZENE	UG/KG	0.9	2	0.5	0.2	2/8	0	280	*	*
	MIREX	UG/KG	0.5	0.5	0.2	0.2	2/8	0	250	*	*
	PCB-101 (2,2',3,5,5')	UG/KG	0.3	2	0.7	0.4	5/8	*	*	*	*
	PCB-105 (2,3,3',4,4')	UG/KG	0.4	2	0.6	0.4	5/8	*	*	*	*
	PCB-118 (2,3',4,4',5)	UG/KG	0.4	4	1	0.5	5/8	*	*	*	*
	PCB-128 (2,2',3,3',4,4')	UG/KG	0.8	0.9	0.3	0.2	2/8	*	*	*	*
	PCB-138 (2,2',3,4,4',5')	UG/KG	0.7	3	1	0.6	5/8	*	*	*	*

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-3

## Tidal Area Landfill (Site 1)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria		
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	PRG Value > PRG Value
LOW LEVEL PESTICIDES AND PCBs	PCB-153 (2,2',4,4',5,5')	UG/KG	0.6	2	0.9	0.5	5/8	*
	PCB-170 (2,2',3,3',4,4',5)	UG/KG	0.5	0.5	0.2	0.2	1/8	*
	PCB-18 (2,2',5)	UG/KG	0.2	2	0.5	0.3	4/8	*
	PCB-180 (2,2',3,4,4',5,5')	UG/KG	0.6	2	0.7	0.4	5/8	*
	PCB-187 (2,2',3,4',5,5',6)	UG/KG	0.2	0.7	0.3	0.3	5/8	*
	PCB-195 (2,2',3,3',4,4',5,6)	UG/KG	0.7	0.7	0.2	0.2	1/8	*
	PCB-206 (2,2',3,3',4,4',5,5')	UG/KG	0.3	0.5	0.3	0.2	3/8	*
	PCB-28 (2,4,4')	UG/KG	2	2	0.4	0.2	1/8	*
	PCB-44 (2,2',3,5')	UG/KG	0.3	3	0.5	0.2	2/8	*
	PCB-52 (2,2',5,5')	UG/KG	0.2	2	0.5	0.3	4/8	*
LOW LEVEL SEMIVOLATILES	PCB-66 (2,3',4,4')	UG/KG	3	4	0.9	0.3	2/8	*
	PCB-77 (3,3',4,4')	UG/KG	0.2	1	0.4	0.2	3/8	*
	TOTAL DDTs	UG/KG	5	48	12	5	5/8	*
	TOTAL PCBs	UG/KG	3	33	10	7	6/8	*
	TRANS-NONACHLOR	UG/KG	0.8	4	2	0.7	5/8	*
	2,6-DIMETHYLNAPHTHALENE	UG/KG	30	30	230	140	1/8	*
	BENZO(A)ANTHRACENE	UG/KG	33	68	200	110	3/8	*
	BENZO(A)PYRENE	UG/KG	68	68	230	160	1/8	*
	BENZO(B)FLUORANTHENE	UG/KG	50	85	210	120	3/8	*
	BENZO(E)PYRENE	UG/KG	46	47	200	110	3/8	*
	BENZO(G,H,I)PERYLENE	UG/KG	66	66	230	160	1/8	*
	BENZO(K)FLUORANTHENE	UG/KG	41	75	200	110	3/8	*
	BENZOIC ACID	UG/KG	14	1,100	370	120	6/8	*
								100,000,000

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-3

## Tidal Area Landfill (Site 1)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria			
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRG	PRG Value
LOW LEVEL SEMIVOLATILES	BUTYLBENZYLPHthalate	UG/KG	45	45	220	140	1/8	0	930,000
	CHRYSENE	UG/KG	59	110	210	130	3/8	0	6,100
	FLUORANTHENE	UG/KG	99	150	170	130	4/8	0	2,000,000
	HIGH MOLECULAR PAHs	UG/KG	910	7,800	2,400	1,600	5/8	*	*
	INDENO(1,2,3-CD)PYRENE	UG/KG	47	47	230	150	1/8	0	560
	LOW MOLECULAR PAHs	UG/KG	390	720	1,100	760	3/8	*	*
	PERYLENE	UG/KG	39	39	230	150	1/8	*	*
	PHENANTHRENE	UG/KG	32	41	190	100	3/8	*	*
	PHENOL	UG/KG	19,000	19,000	2,500	250	1/8	0	33,000,000
	PYRENE	UG/KG	78	1,300	320	170	4/8	0	1,500,000
	TOTAL PAHs	UG/KG	1,300	11,000	3,500	2,300	5/8	*	*

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-4

## R Area Disposal Site (Site 2)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria			
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRG	PRG Value	Ambient Value
SEMI-VOLATILES	ACENAPHTHENE	UG/KG	550	650	380	340	1/20	0	2,600,000	*
	ANTHRACENE	UG/KG	1,200	1,200	400	350	1/20	0	14,000,000	*
	BENZO(A)ANTHRACENE	UG/KG	320	2,000	450	370	2/20	1	560	*
	BENZO(A)PYRENE	UG/KG	1,500	1,500	420	350	1/20	1	56	*
	BENZO(B)FLUORANTHENE	UG/KG	290	2,300	450	370	2/20	1	560	*
	BENZO(G,H,I)PERYLENE	UG/KG	520	520	370	340	1/20	*	*	*
	BENZO(K)FLUORANTHENE	UG/KG	820	820	380	340	1/20	1	610	*
	CARBAZOLE	UG/KG	1,100	1,100	400	350	1/20	0	22,000	*
	CHRYSENE	UG/KG	300	1,800	440	360	2/20	0	6,100	*
	DIBENZOFURAN	UG/KG	500	500	370	340	1/20	0	210,000	*
	FLUORANTHENE	UG/KG	640	5,000	610	400	2/20	0	2,000,000	*
	FLUORENE	UG/KG	600	600	370	340	1/20	0	1,800,000	*
	HIGH MOLECULAR PAHS	UG/KG	3,000	19,000	4,100	3,300	2/20	*	*	*
	INDENO(1,2,3-CD)PYRENE	UG/KG	530	530	370	340	1/20	0	560	*
	LOW MOLECULAR PAHS	UG/KG	1,200	8,700	2,200	1,800	2/20	*	*	*
TOTAL METALS	NAPHTHALENE	UG/KG	300	300	360	330	1/20	0	55,000	*
	PHENANTHRENE	UG/KG	440	5,900	650	390	2/20	*	*	*
	PHENOL	UG/KG	470	600	390	360	2/20	0	33,000,000	*
	PYRENE	UG/KG	630	4,300	580	400	2/20	0	1,500,000	*
	TOTAL PAHS	UG/KG	4,200	27,000	6,200	5,100	2/20	*	*	*
	ALUMINUM	MG/KG	4,420	33,700	18,300	0	133/133	0	75,000	13
	ANTIMONY	MG/KG	0.53	7.1	1.1	0.89	76/131	0	30.0	12
										27,300
										2.2

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

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The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-4

## R Area Disposal Site (Site 2)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analyte	Unit	Detected Results				Screening Criteria			
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	PRG Value	Ambient Value	Ambient Value
TOTAL METALS	ARSENIC MG/KG	2.3	47.2	12.4	10.4	128/133	128	0.38	8
	BARUM MG/KG	25.7	7,710	135	114	133/133	1	5,200	1
	BERYLLIUM MG/KG	0.11	0.57	0.078	0.035	16/133	0	150	10
	CADMIUM MG/KG	0.40	0.83	0.078	0.036	5/133	0	9.0	0
	CALCIUM MG/KG	1,870	45,900	7,940	0	133/133	*	*	*
	CHROMIUM MG/KG	18.2	319	56.5	50.0	126/133	1	210	15
	COBALT MG/KG	3.7	108	16.4	15.0	133/133	0	3,300	2
	COPPER MG/KG	13.0	272	45.0	40.4	133/133	0	2,800	5
	IRON MG/KG	12,300	135,000	31,200	0	133/133	107	22,000	1
	LEAD MG/KG	4.7	1,160	55.9	37.6	132/133	14	130	22
	MAGNESIUM MG/KG	4,670	27,400	11,100	0	133/133	*	*	*
	MANGANESE MG/KG	59.0	6,300	536	0	133/133	1	3,100	2
	MERCURY MG/KG	0.050	1.6	0.20	0.13	93/133	0	22.0	26
	MOLYBDENUM MG/KG	0.32	53.7	1.4	0.37	35/133	0	370	3
	NICKEL MG/KG	25.0	242	71.0	57.1	133/133	1	150	5
	POTASSIUM MG/KG	1,720	10,660	4,400	0	133/133	*	*	*
VOLATILES	SELENIUM MG/KG	1.0	2.8	0.60	0.54	3/133	0	370	*
	SILVER MG/KG	0.21	0.72	0.13	0.10	9/133	0	370	*
	SODIUM MG/KG	48.2	117,000	10,800	0	121/133	*	*	*
	THALLIUM MG/KG	0.65	5.4	0.43	0.35	10/133	1	5.2	2
	VANADIUM MG/KG	32.3	130	67.6	65.4	133/133	0	520	10
	ZINC MG/KG	40.4	959	146	121	133/133	0	22,000	11
	2-BUTANONE UG/KG	43	73	19	13	2/20	0	6,900,000	*

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

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Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-4

## R Area Disposal Site (Site 2)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Results		
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	PRG Value
VOLATILES	CARBON DISULFIDE	UG/KG	7	160	20	12	4/20	350,000
	CHLOROMETHANE	UG/KG	14	14	11	10	1/20	1,200
LOW LEVEL PESTICIDES AND PCBs	2,4'-DDD	UG/KG	0.3	7	0.8	0.3	32/67	*
	2,4'-DDE	UG/KG	0.3	1	0.2	0.1	14/67	*
	2,4'-DDT	UG/KG	0.2	5	0.5	0.2	33/67	*
	4,4'-DDD	UG/KG	0.3	26	2	0.5	42/67	2,400
	4,4'-DDE	UG/KG	0.2	9	1	0.7	57/67	1,700
	4,4'-DDT	UG/KG	0.2	28	2	0.6	43/67	1,700
	ALDRIN	UG/KG	0.2	0.3	0.2	0.1	11/67	26
	ALPHA-CHLORDANE	UG/KG	0.2	3	0.5	0.2	32/67	1,600
	DIELDRIN	UG/KG	0.2	2	0.3	0.1	19/67	28
	GAMMA-BHC (LINDANE)	UG/KG	0.3	0.9	0.2	0.1	7/67	420
	HEPTACHLOR	UG/KG	0.3	0.4	0.1	0.1	2/67	990
	HEPTACHLOR EPOXIDE	UG/KG	0.2	1	0.1	0.1	8/67	49
	HEXACHLOROBENZENE	UG/KG	0.2	2	0.2	0.1	19/67	280
	MIREX	UG/KG	0.05	1	0.2	0.1	16/67	250
	PCB-101 (2,2',3,5,5')	UG/KG	0.07	1	0.2	0.1	27/67	*
	PCB-105 (2,3,3',4,4')	UG/KG	0.1	1	0.2	0.1	20/67	*
	PCB-118 (2,3',4,4',5)	UG/KG	0.09	1	0.3	0.2	25/67	*
	PCB-126 (3,3',4,4',5)	UG/KG	0.2	4	0.3	0.1	13/67	*
	PCB-128 (2,2',3,3',4,4')	UG/KG	0.2	0.6	0.1	0.1	7/67	*
	PCB-138 (2,2',3,4,4',5')	UG/KG	0.2	2	0.4	0.2	32/67	*
	PCB-153 (2,2',4,4',5,5')	UG/KG	0.07	2	0.3	0.2	30/67	*

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

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Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.



Table 6-4

## R Area Disposal Site (Site 2)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria		
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRG	PRG Value
LOW LEVEL PESTICIDES AND PCBs	PCB-179 (2,2',3,3',4,4',5)	UG/KG	0.3	0.9	0.1	0.1	5/67	*	*
	PCB-19 (2,2',5)	UG/KG	0.1	0.4	0.1	0.1	12/67	*	*
	PCB-180 (2,2',3,4,4',5,5')	UG/KG	0.1	2	0.2	0.1	19/67	*	*
	PCB-197 (2,2',3,4',5,5',6)	UG/KG	0.07	0.8	0.2	0.1	15/67	*	*
	PCB-195 (2,2',3,3',4,4',5,6)	UG/KG	0.1	0.4	0.1	0.09	3/67	*	*
	PCB-205 (2,2',3,3',4,4',5,5')	UG/KG	0.05	1	0.2	0.1	19/67	*	*
	PCB-209 (2,2',3,3',4,4',5,5',6)	UG/KG	0.2	0.4	0.1	0.09	2/67	*	*
	PCB-28 (2,4,4')	UG/KG	0.4	0.5	0.1	0.09	2/67	*	*
	PCB-44 (2,2',3,5')	UG/KG	0.2	0.3	0.1	0.1	3/67	*	*
	PCB-52 (2,2',5,5')	UG/KG	0.06	1	0.2	0.1	20/67	*	*
LOW LEVEL SEMIVOLATILES	PCB-66 (2,3',4,4')	UG/KG	0.09	1	0.2	0.1	15/67	*	*
	PCB-77 (3,3',4,4')	UG/KG	0.09	1	0.2	0.1	15/67	*	*
	PCB-8 (2,4')	UG/KG	0.3	4	0.4	0.2	21/67	*	*
	TOTAL DDTs	UG/KG	0.5	73	7	3	61/67	*	*
	TOTAL PCBs	UG/KG	1	14	4	3	56/67	0	200
	TRANS-NONACHLOR	UG/KG	0.2	2	0.5	0.2	30/67	*	*
	1-METHYLENANTHRENE	UG/KG	37	37	93	59	1/67	*	*
	2,4-DIMETHYLPHENOL	UG/KG	24	24	60	60	1/67	0	1,100,000
	2,6-DIMETHYLNAPHTHALENE	UG/KG	13	130	83	55	5/67	*	*
	2-METHYLNAPHTHALENE	UG/KG	42	42	91	58	1/67	*	*
LOW LEVEL SEMIVOLATILES	4-METHYLPHENOL	UG/KG	34	740	94	58	5/67	0	270,000
	ACENAPHTHENE	UG/KG	15	30	20	56	3/67	0	2,600,000
	ANTHRACENE	UG/KG	24	100	90	57	5/67	0	14,000,000

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

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The minimum and the maximum results were calculated using the detected values.

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Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-4

## R Area Disposal Site (Site 2)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria				
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	PRG Value	PRG Value	Ambient Value
LOW LEVEL SEMIVOLATILES	BENZO(A)ANTHRACENE	UG/KG	12	440	86	54	14/67	0	560	*
	BENZO(A)PYRENE	UG/KG	13	320	83	52	16/67	9	56	*
	BENZO(B)FLUORANTHENE	UG/KG	6	390	91	55	16/67	0	550	*
	BENZO(E)PYRENE	UG/KG	11	230	86	54	13/67	*	*	*
	BENZO(G, H, I)PERYLENE	UG/KG	15	220	89	57	12/67	*	*	*
	BENZO(K)FLUORANTHENE	UG/KG	11	320	85	54	13/67	0	610	*
	BENZOIC ACID	UG/KG	18	920	200	130	20/67	0	100,000,000	*
	BIS(2-ETHYLHEXYL) PHTHALATE	UG/KG	87	180	100	66	2/67	0	32,000	*
	CARBAZOLE	UG/KG	24	40	92	58	2/67	0	22,000	*
	CHRYSENE	UG/KG	6	440	92	55	18/67	0	6,100	*
	DIBENZ(A, H)ANTHRACENE	UG/KG	10	94	89	57	5/67	3	56	*
	DIBENZOTHIOPHENE	UG/KG	23	23	92	59	1/67	*	*	*
	DIETHYLPHTHALATE	UG/KG	160	160	95	61	1/67	0	44,000,000	*
	FLUORANTHENE	UG/KG	10	1,100	110	57	21/67	0	2,000,000	*
	FLUORENE	UG/KG	25	25	92	58	1/67	0	1,800,000	*
	HIGH MOLECULAR PAHS	UG/KG	200	4,400	980	630	23/67	*	*	*
	INDENO(1, 2, 3-CD)PYRENE	UG/KG	12	190	85	55	12/67	0	560	*
	ISOPHORONE	UG/KG	38	38	93	60	1/67	0	470,000	*
	LOW MOLECULAR PAHS	UG/KG	110	1,100	460	290	12/67	*	*	*
NAPHTHALENE	UG/KG	18	210	94	59	3/67	0	55,000	*	
PERYLENE	UG/KG	9	160	85	56	9/67	*	*	*	
PHENANTHRENE	UG/KG	7	660	94	55	12/67	*	*	*	
PYRENE	UG/KG	6	680	96	55	21/67	0	1,500,000	*	

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

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Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-4

## R Area Disposal Site (Site 2)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria							
			Minimum		Maximum		Arithmetic Mean		Geometric Mean		Total	PRG Value	PRG Value	Ambient Value
LCM LEVEL SEMIVOLATILES	TOTAL PAHS	UG/KG	310	6,000	1,400	530	23/67	*	*	*	*			

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

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The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

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Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-5

## Froid &amp; Taylor Site (Site 9)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analyte	Unit	Detected Results				Screening Criteria			
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	PRG Value	Ambient Value	Ambient Value
PESTICIDES	4,4'-DDD	8	8		9	5	1/9	0	2,400
	4,4'-DDE	10	10		6	5	1/9	0	1,700
	4,4'-DDT	9	9		5	5	1/9	0	1,700
SEMI-CLATILES	ALPHA-CHLORDANE	35	35		6	3	1/9	0	1,600
	GAMMA-CHLORDANE	25	25		5	3	1/9	0	1,600
	TOTAL DDTs	24	55		20	15	2/9	*	
TOTAL METALS	4-METHYLPHENOL	300	300		450	390	1/12	0	270,000
	CHRYSENE	36	76		350	260	2/11	0	6,100
	FLUORANTHENE	43	140		360	280	2/11	0	2,000,000
	HIGH MOLECULAR PAHS	2,500	4,500		3,700	3,300	2/11	*	
TOTAL METALS	PHENOL	160	500		490	420	3/12	0	33,000,000
	PYRENE	110	110		380	330	1/11	0	1,500,000
	TOTAL PAHS	4,200	8,000		5,900	5,300	2/11	*	
TOTAL METALS	ALUMINUM	4,810	37,500		13,700	12,200	21/21	0	75,000
	ANTIMONY	1.1	2.2		1.3	1.2	3/6	0	30.0
	ARSENIC	4.5	25.6		9.8	7.2	18/21	18	0.38
	BARIUM	27.7	234		117	94.2	21/21	0	5,200
TOTAL METALS	BERYLLIUM	0.35	0.35		0.050	0.031	1/21	0	150
	CADMIUM	0.32	1.9		0.34	0.13	8/21	0	9.0
	CALCIUM	2,160	37,500		8,000	6,350	21/21	*	*
	CHROMIUM	15.3	105		41.0	35.8	21/21	0	210
TOTAL METALS	COBALT	3.6	20.6		9.8	9.1	21/21	0	3,300

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-5

## Froid &amp; Taylor Site (Site 9)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analyte	Unit	Detected Results				Screening Criteria			
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRG	PRG Value	Ambient Value
TOTAL METALS	COPPER	13.1	92.0	40.5	35.3	21/21	0	2,800	2
	IRON	5,860	47,100	19,700	17,900	21/21	4	22,000	0
	LEAD	3.5	515	79.1	34.1	21/21	4	130	5
	MAGNESIUM	1,890	15,400	8,670	8,210	21/21	*	*	*
	MANGANESE	60.7	3,520	413	248	21/21	1	3,100	1
	MERCURY	0.070	0.49	0.18	0.14	14/21	0	22.0	4
	MOLYBDENUM	0.22	4.3	1.1	0.41	6/21	0	370	0
	NICKEL	15.6	90.9	48.9	44.8	21/21	0	150	0
	POTASSIUM	823	6,510	2,900	2,640	21/21	*	*	*
	SELENIUM	1.2	1.5	0.81	0.69	2/21	0	370	*
	SILVER	0.15	0.63	0.21	0.16	7/21	0	370	*
	SODIUM	1,160	60,400	11,900	6,200	21/21	*	*	*
	THALLIUM	0.64	3.9	0.73	0.52	4/21	0	5.2	1
	VARACIUM	32.6	136	58.4	54.3	21/21	0	520	2
	ZINC	27.5	436	119	95.9	21/21	0	22,000	1
TPH EXTRACTABLES	MG/KG	9	23,000	2,300	130	15/18	*	*	*
VOLATILES	4-METHYL-2-PENTANONE	27	27	13	13	1/9	0	750,000	*
	2,4'-DDD	0.3	7	2	0.5	6/12	*	*	*
LOW LEVEL PESTICIDES AND PCBs	2,4'-DDE	0.4	0.6	0.3	0.2	4/12	*	*	*
	2,4'-DDT	1	3	0.7	0.3	4/12	*	*	*
	4,4'-DDD	0.3	14	5	2	9/12	0	2,400	*
	4,4'-DDE	0.3	15	3	1	9/12	0	1,700	*

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-5

## Froid &amp; Taylor Site (Site 9)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria			
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	PRG Value	> Ambient Value	Ambient Value
LOW LEVEL PESTICIDES AND PCBs	4,4'-DDT	UG/KG	0.5	19	4	0.6	5/12	0	1,700	*
	ALDRIN	UG/KG	0.4	0.4	0.2	0.1	3/12	0	26	*
	ALPHA-BHC	UG/KG	0.7	0.7	0.2	0.2	1/3	0	86	*
	ALPHA-CHLORDANE	UG/KG	0.3	11	2	0.6	9/12	0	1,600	*
	DIELDRIN	UG/KG	0.4	0.8	0.2	0.2	2/12	0	28	*
	GAMMA-BHC (LINDANE)	UG/KG	0.4	0.4	0.2	0.1	1/12	0	420	*
	GAMMA-CHLORDANE	UG/KG	0.4	12	5	2	3/3	0	1,600	*
	HEXACHLOROBENZENE	UG/KG	0.4	0.5	0.2	0.2	3/12	0	280	*
	PCB-101 (2,2',3,5,5')	UG/KG	0.1	0.4	0.2	0.1	2/12	*	*	*
	PCB-105 (2,3,3',4,4')	UG/KG	0.2	0.3	0.2	0.1	2/12	*	*	*
	PCB-118 (2,3',4,4',5)	UG/KG	0.1	0.7	0.2	0.1	3/12	*	*	*
	PCB-126 (3,3',4,4',5)	UG/KG	0.1	0.1	0.1	0.1	2/12	*	*	*
	PCB-128 (2,2',3,3',4,4')	UG/KG	0.1	2	0.3	0.2	3/12	*	*	*
	PCB-138 (2,2',3,4,4',5')	UG/KG	0.3	2	0.4	0.2	5/12	*	*	*
	PCB-153 (2,2',4,4',5,5')	UG/KG	0.1	0.9	0.3	0.2	4/12	*	*	*
	PCB-180 (2,2',3,4,4',5,5')	UG/KG	0.1	0.4	0.2	0.2	3/12	*	*	*
	PCB-187 (2,2',3,4',5,5',6)	UG/KG	0.07	0.4	0.2	0.1	3/12	*	*	*
	PCB-206 (2,2',3,3',4,4',5,5',6)	UG/KG	0.2	2	0.6	0.3	1/3	*	*	*
	PCB-206 (2,2',3,3',4,4',5,5',6)	UG/KG	0.2	0.8	0.3	0.2	4/9	*	*	*
	PCB-209 (2,2',3,3',4,4',5,5',6)	UG/KG	0.08	0.8	0.2	0.2	3/12	*	*	*
	PCB-77 (3,3',4,4')	UG/KG	0.3	0.3	0.1	0.1	1/12	*	*	*
	TECHNICAL CHLORDANE	UG/KG	21	190	110	63	2/2	*	*	*
	TOTAL DDTs	UG/KG	1	43	15	6	9/12	*	*	*

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-5

## Froid &amp; Taylor Site (Site 9)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analyte	Unit	Detected Results			Screening Criteria			
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRG	PRG Value
LOW LEVEL PESTICIDES AND PCBs	UG/KG	2	9	4	4	7/12	0	200
TRANS-NONACHLOR	UG/KG	0.2	4	1	0.5	7/12	*	*
LOW LEVEL SEMI-VOLATILES	UG/KG	9	9	100	61	1/9	*	*
1,1'-BIPHENYL	UG/KG	5	30	100	59	2/9	*	*
1-METHYLNAPHTHALENE	UG/KG	5	12	100	54	2/9	0	1,100,000
2,4-DIMETHYLPHENOL	UG/KG	5	41	93	50	3/9	*	*
2,6-DIMETHYLNAPHTHALENE	UG/KG	5	41	93	50	3/9	*	*
2-METHYLNAPHTHALENE	UG/KG	9	46	110	65	2/9	*	*
4-METHYLPHENOL	UG/KG	5	5	100	57	1/9	0	270,000
ACENAPHTHYLENE	UG/KG	29	29	96	59	1/9	*	*
ANTHRACENE	UG/KG	37	37	99	51	1/9	0	14,000,000
BENZO(A)ANTHRACENE	UG/KG	53	91	82	53	3/9	0	560
BENZO(A)PYRENE	UG/KG	120	130	110	59	2/9	2	56
BENZO(B)FLUORANTHENE	UG/KG	110	240	120	73	2/9	0	560
BENZO(E)PYRENE	UG/KG	280	280	130	76	1/9	*	*
BENZO(G,H,I)PERYLENE	UG/KG	170	210	120	75	2/9	*	*
BENZO(K)FLUORANTHENE	UG/KG	83	120	100	65	2/9	0	610
BENZOIC ACID	UG/KG	24	530	260	130	4/9	0	100,000,000
BIS(2-ETHYLHEXYL)PHTHALATE	UG/KG	2,500	2,500	360	91	1/9	0	32,000
CARBAZOLE	UG/KG	24	24	97	58	1/9	0	22,000
CHRYSENE	UG/KG	88	240	110	68	3/9	0	6,100
DIBENZOFLURAN	UG/KG	7	7	100	59	1/9	0	210,000
FLUORANTHENE	UG/KG	61	190	110	68	4/9	0	2,000,000
FLUORENE	UG/KG	6	6	100	58	1/9	0	1,800,000

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1993).

\* Screening values not available.

Table 6-5

## Froid &amp; Taylor Site (Site 9)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria		
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	PRG Value
LOW LEVEL SEMIVOLATILES	HIGH MOLECULAR PAHS	UG/KG	1,200	1,800	1,200	770	4/9	*
	INDENO(1,2,3-CD)PYRENE	UG/KG	140	140	110	70	1/9	560
	LOW MOLECULAR PAHS	UG/KG	94	730	490	310	4/9	*
	NAPHTHALENE	UG/KG	14	14	100	64	1/9	55,000
TOTAL PAHS	PHENANTHRENE	UG/KG	31	49	74	46	3/9	*
	PYRENE	UG/KG	110	200	110	69	3/9	1,500,000
	TOTAL PAHS	UG/KG	160	2,300	1,700	1,100	5/9	*

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

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The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to one significant figure, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.





Table 6-6

## Wood Hogger Site (Site 11)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria			
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PPG	PPG Value	Ambient Value
AROMATIC VOLATILES	ETHYLENE	UG/KG	160	160	160	160	1/1	0	230,000	*
	XYLENE (TOTAL)	UG/KG	220	220	220	220	1/1	0	210,000	*
HEXAVALENT CHROMIUM	HEXAVALENT CHROMIUM	UG/KG	60.0	50.0	28.7	11.4	1/3	0	200	*
DIOXIN	1,2,3,4,6,7,8,9-OCDD	UG/KG	0.4	140	25	5	9/11	*	*	*
	1,2,3,4,6,7,8,9-OCDF	UG/KG	0.5	13	2	0.5	3/11	*	*	*
	1,2,3,4,6,7,8-HPCDD	UG/KG	0.5	15	3	0.9	4/11	*	*	*
	1,2,3,4,6,7,8-HPCDF	UG/KG	0.1	3	0.6	0.3	4/11	*	*	*
	TOTAL HPCDD	UG/KG	0.8	41	10	3	7/11	*	*	*
	TOTAL HPCDF	UG/KG	0.3	13	2	0.7	5/11	*	*	*
EXPLOSIVES	TOTAL HXCDF	UG/KG	1	4	0.6	0.3	2/11	*	*	*
	TOTAL TCDD	UG/KG	2	13	4	2	9/11	*	*	*
	1,3-DINITROBENZENE	UG/KG	130	130	62	61	1/38	0	5,500	*
	BMX	UG/KG	360	360	68	63	1/38	0	2,700,000	*
PESTICIDES	4,4'-DDD	UG/KG	2	9	4	3	4/55	0	2,400	*
	4,4'-DDE	UG/KG	2	2	4	3	1/55	0	1,700	*
	4,4'-DDT	UG/KG	3	11	4	3	3/55	0	1,700	*
	ALPHA-CHLORDANE	UG/KG	2	2	2	2	1/55	0	1,600	*
	ENDRIN KETONE	UG/KG	4	4	4	3	1/55	*	*	*
	TOTAL DDTs	UG/KG	6	23	13	10	4/55	*	*	*
SEMIVOLATILES	BENZ(a)FLUORANTHENE	UG/KG	440	440	510	300	1/50	0	560	*
	CARBAZOLE	UG/KG	350	350	510	300	1/50	0	22,000	*

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-6

## Wood Hogger Site (Site 11)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria			
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRG	PRG Value	Ambient Value
SEMIVOLATILES	CHRYSENE	UG/KG	330	330	513	300	1/60	0	6,100	*
	FLUORANTHENE	UG/KG	780	780	523	310	1/60	0	2,000,000	*
	HIGH MOLECULAR PAHS	UG/KG	3,800	3,800	4,600	2,700	1/60	*	*	*
	LOW MOLECULAR PAHS	UG/KG	1,800	1,800	2,500	1,500	1/60	*	*	*
TOTAL PAHS	PHENANTHRENE	UG/KG	490	490	510	300	1/60	*	*	*
	PHENOL	UG/KG	200	4,600	780	400	17/60	0	33,000,000	*
	PYRENE	UG/KG	540	540	510	300	1/60	0	1,500,000	*
	TOTAL PAHS	UG/KG	5,500	5,500	7,100	4,200	1/60	*	*	*
TOTAL METALS	ALUMINUM	MG/KG	82.2	42,700	14,700	0	126/128	0	75,000	9
	ANTIMONY	MG/KG	0.44	7.1	1.3	0.87	72/127	0	30.0	16
	ARSENIC	MG/KG	1.3	37.0	8.4	5.0	117/128	117	0.38	27.0
	BARIUM	MG/KG	1.1	546	135	98.5	126/128	0	5,200	1
	BERYLLIUM	MG/KG	0.010	0.84	0.11	0.043	40/128	0	150	22
	CADMIUM	MG/KG	0.050	20.8	0.94	0.088	37/128	3	9.0	11
	CALCIUM	MG/KG	132	112,000	8,990	0	128/128	*	*	*
	CHROMIUM	MG/KG	6.4	122	39.2	31.7	125/128	0	210	7
	COBALT	MG/KG	1.7	39.3	13.9	11.6	126/128	0	3,300	1
	COPPER	MG/KG	9.72	507	46.6	32.8	124/128	0	2,800	15
	IRON	MG/KG	367	90,300	26,900	0	128/128	65	22,000	1
	LEAD	MG/KG	0.35	728	51.4	18.5	126/128	13	130	16
	MAGNESIUM	MG/KG	81.6	22,400	9,140	0	128/128	*	*	*
	MANGANESE	MG/KG	4.3	1,470	450	0	128/128	0	3,100	0
	MERCURY	MG/KG	0.030	18.5	0.53	0.12	72/127	0	22.0	22

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-6

## Wood Hogger Site (Site 11)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analyte	Unit	Detected Results				Screening Criteria				
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRG Value	> Ambient Value	Ambient Value	
TOTAL METALS	MOLYBDENUM	MG/KG	0.25	12.9	1.1	0.34	45/128	0	370	6.6
	NICKEL	MG/KG	6.3	123	47.1	37.9	125/128	0	150	120
	POTASSIUM	MG/KG	59.3	6,520	2,450	0	128/128	*	*	*
	SELENIUM	MG/KG	0.67	4.8	0.71	0.57	6/128	0	370	*
	SILVER	MG/KG	0.15	4.4	0.22	0.12	10/128	0	370	*
	SODIUM	MG/KG	36.9	275,000	8,690	0	125/128	*	*	*
	THALLIUM	MG/KG	0.69	2.4	0.45	0.32	11/128	0	5.2	2.2
	VANADIUM	MG/KG	0.28	163	61.0	53.1	128/128	0	520	96.0
	ZINC	MG/KG	27.7	3,010	191	93.9	116/128	0	22,000	21
	264									
TPH EXTRACTABLES	DIESEL RANGE ORGANICS	MG/KG	2,300	2,300	340	18	1/7	*	*	*
	MOTOR OIL RANGE ORGANICS	MG/KG	640	8,900	1,400	34	2/7	*	*	*
TPH PURGEABLES	GASOLINE RANGE ORGANICS	MG/KG	0.5	26	4	0.6	2/7	*	*	*
VOLATILES	2-BUTANONE	UG/KG	20	720	30	11	3/55	0	6,900,000	*
	ACETONE	UG/KG	300	300	76	29	1/55	0	1,400,000	*
	CARBON DISULFIDE	UG/KG	23	290	20	11	8/55	0	350,000	*
	XYLENE (TOTAL)	UG/KG	26	54	11	9	2/55	0	210,000	*
LOW LEVEL PESTICIDES AND PCBs	2,4'-DDD	UG/KG	0.3	8	1	0.4	23/50	*	*	*
	2,4'-DDE	UG/KG	0.4	3	0.4	0.2	6/50	*	*	*
	2,4'-DDT	UG/KG	0.1	34	2	0.3	17/50	*	*	*
	4,4'-DDD	UG/KG	0.2	280	9	0.8	35/50	0	2,400	*
4,4'-DDE	UG/KG	0.2	32	3	0.8	40/50	0	1,700	*	

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-6

## Wood Hogger Site (Site II)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analyte	Unit	Detected Results				Screening Criteria			
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	s. PRG	PRG Value	Ambient Value
4,4'-DDT	UG/KG	0.3	230	11	0.7	30/50	0	1,700	*
ALDRIN	UG/KG	0.2	0.5	0.4	0.2	5/50	0	26	*
ALPHA-CHLORDANE	UG/KG	0.2	78	5	0.7	36/50	0	1,600	*
D-ELORIN	UG/KG	0.2	6	0.7	0.3	14/50	0	28	*
GAMMA-BHC (LINDANE)	UG/KG	0.4	2	0.5	0.2	5/50	0	420	*
HEPTACHLOR EPOXIDE	UG/KG	0.3	2	0.4	0.2	4/50	0	990	*
HEXACHLOROBENZENE	UG/KG	0.2	0.4	0.5	0.2	4/50	0	49	*
MIREX	UG/KG	0.1	5	0.5	0.2	10/50	0	250	*
PCB-101 (2,2',3,5,5')	UG/KG	0.07	7	0.8	0.3	24/50	*	*	*
PCB-105 (2,3',3',4',4')	UG/KG	0.1	3	0.6	0.3	18/50	*	*	*
PCB-118 (2,3',4,4',5')	UG/KG	0.1	5	0.7	0.3	19/50	*	*	*
PCB-126 (3,3',4,4',5')	UG/KG	0.1	6.6	0.4	0.2	5/50	*	*	*
PCB-128 (2,2',3,3',4,4')	UG/KG	0.2	3	0.4	0.2	5/50	*	*	*
PCB-138 (2,2',3,4,4',5')	UG/KG	0.2	12	1	0.4	26/50	*	*	*
PCB-153 (2,2',4,4',5,5')	UG/KG	0.1	10	1	0.3	18/50	*	*	*
PCB-170 (2,2',3,3',4,4',5)	UG/KG	0.1	7	0.6	0.2	10/50	*	*	*
PCB-18 (2,2',5)	UG/KG	0.1	0.9	0.4	0.2	7/50	*	*	*
PCB-180 (2,2',3,4,4',5,5')	UG/KG	0.1	15	1	0.3	20/50	*	*	*
PCB-187 (2,2',3,4',5,5',6)	UG/KG	0.09	7	0.7	0.2	17/50	*	*	*
PCB-195 (2,2',3,3',4,4',5,6)	UG/KG	0.2	1	0.4	0.2	4/50	*	*	*
PCB-205 (2,2',3,3',4,4',5,5')	UG/KG	0.2	0.9	0.4	0.2	11/50	*	*	*
PCB-209 (2,2',3,3',4,4',5,5',6)	UG/KG	0.2	0.3	0.4	0.2	3/50	*	*	*

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-6

## Wood Hogger Site (Site 11)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria			
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRG	PRG Value > Ambient
LOW LEVEL PESTICIDES AND PCBs	PCB-28 (2,4,4')	UG/KG	0.2	2	0.4	0.2	4/50	*	*
	PCB-44 (2,2',3,5')	UG/KG	0.2	2	0.5	0.2	10/50	*	*
	PCB-52 (2,2',5,5')	UG/KG	0.28	2	0.5	0.2	18/50	*	*
	PCB-55 (2,3',4,4')	UG/KG	0.2	1	0.4	0.2	5/50	*	*
	PCB-77 (3,3',4,4')	UG/KG	0.3	0.9	0.4	0.2	2/50	*	*
	PCB-8 (2,4')	UG/KG	0.2	6	0.5	0.2	7/50	*	*
	TOTAL PCBs	UG/KG	0.7	330	26	4	43/50	*	*
LOW LEVEL SEMIVOLATILES	TRANS-NONACHLOR	UG/KG	0.2	65	4	0.7	34/50	*	*
	1-METHYLPHENANTHRENE	UG/KG	10	350	690	200	2/50	*	*
	2,6-DIMETHYLNAPHTHALENE	UG/KG	37	37	690	200	1/50	*	*
	ACENAPHTHENE	UG/KG	27	280	690	200	4/50	0	2,600,000
	ACENAPHTHYLENE	UG/KG	270	270	690	200	1/50	0	*
	ANTHRACENE	UG/KG	14	2,100	710	200	10/50	0	14,000,000
	BENZO(A)ANTHRACENE	UG/KG	12	3,800	650	190	12/50	1	560
	BENZO(A)PYRENE	UG/KG	19	2,700	760	190	14/50	9	56
	BENZO(B)FLUORANTHENE	UG/KG	25	3,100	760	220	15/50	4	560
	BENZO(E)PYRENE	UG/KG	19	2,400	630	190	24/50	*	*
	BENZO(G,H,I)PERYLENE	UG/KG	21	1,100	670	190	11/50	*	*
	BENZO(K)FLUORANTHENE	UG/KG	20	3,400	730	200	13/50	2	610
	BENZOIC ACID	UG/KG	40	2,300	1,700	460	8/50	0	100,000,000
	BUTYLBENZYLPHTHALATE	UG/KG	78	78	630	200	1/50	0	930,000

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-6

## Wood Hogger Site (Site 11)

## Statistical Summary of Soil and Sediment Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria		
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	> PRG Value
LOW LEVEL SEMIVOLATILES	CARBAZOLE	UG/KG	19	880	676	190	12/50	0
	CHRYSENE	UG/KG	23	6,400	860	230	19/50	1
	DIBENZ(A,H)ANTHRACENE	UG/KG	32	600	680	200	4/50	3
	DIBENZOFURAN	UG/KG	94	170	690	200	2/50	0
	DIBENZOTHIOPHENE	UG/KG	25	170	690	190	3/50	*
	FLUORANTHENE	UG/KG	14	14,000	950	230	31/50	0
	FLORENE	UG/KG	20	350	690	190	4/50	0
	HIGH MOLECULAR PAHS	UG/KG	260	53,000	8,100	2,500	31/50	*
	INDENO(1,2,3-CD)PYRENE	UG/KG	17	1,200	690	190	9/50	1
	LOW MOLECULAR PAHS	UG/KG	98	28,000	3,500	1,100	19/50	*
	NAPHTHALENE	UG/KG	110	110	690	200	1/50	0
	PENTACHLOROPHENOL	UG/KG	120	780	1,800	520	4/45	0
	PERYLENE	UG/KG	26	840	690	200	4/50	*
	PHENANTHRENE	UG/KG	22	4,000	690	200	19/50	*
	PYRENE	UG/KG	19	13,000	850	220	30/50	0
	TOTAL PAHS	UG/KG	370	82,000	12,000	3,700	31/50	*

UG/KG = Micrograms per kilogram MG/KG = Milligrams per kilogram

Ambient values are in milligrams per kilogram (MG/KG).

The minimum and the maximum results were calculated using the detected values.

The arithmetic and geometric means were calculated using the detected values for detected results and half of the detection limits for undetected results.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for residential use (EPA 1998).

\* Screening values not available.

Table 6-7

## R Area Disposal Site (Site 2)

First Quarter, July 1995

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	>PWS Tap Water
SOLIDS	TOTAL SUSPENDED SOLIDS	MG/L	10	5,400	440	43	9/14	*
TOTAL METALS	ALUMINUM	UG/L	158	5,570	611	188	9/14	0
	ARSENIC	UG/L	16.7	23.9	6.9	4.0	3/14	3
	BARIUM	UG/L	22.9	316	112	85.0	14/14	0
	CALCIUM	UG/L	31,100	555,000	188,000	111,000	14/14	*
	COBALT	UG/L	0.51	129	15.8	2.2	12/14	0
	COPPER	UG/L	8.3	32.0	6.8	4.6	5/14	0
	IRON	UG/L	384	239,000	25,600	2,960	14/14	*
	LEAD	UG/L	1.5	41.5	4.5	1.5	5/14	2
	MAGNESIUM	UG/L	55,900	1,540,000	399,000	236,000	14/14	*
	MANGANESE	UG/L	103	11,300	2,300	755	14/14	9
	MERCURY	UG/L	0.35	0.35	0.071	0.057	1/14	0
	MOLYBDENUM	UG/L	5.3	10.2	2.9	1.2	4/14	0
	NICKEL	UG/L	211	211	21.6	4.8	1/14	0
	POTASSIUM	UG/L	18,600	309,000	87,500	60,300	14/14	*
	SODIUM	UG/L	463,000	9,360,000	2,700,000	1,760,000	14/14	*
	THALLIUM	UG/L	8.1	8.1	1.5	1.2	1/14	1
VOLATILES	VANADIUM	UG/L	18.5	33.7	5.1	2.3	2/14	0
	ZINC	UG/L	57.6	285	51.0	31.2	5/14	0
	CHLOROMETHANE	UG/L	11	11	5	5	1/14	1

UG/L = Micrograms per liter MG/L = Milligrams per liter NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.





Table 6-8

## R Area Disposal Site (Site 2)

Second Quarter, October 1995

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	PRG Tap Water
SOLIDS	TOTAL SUSPENDED SOLIDS	MG/L	21	130	65	48	6/6	*
PESTICIDES	4,4'-DDT	UG/L	0.03	0.03	0.05	0.05	1/6	0
	ALDRIN	UG/L	0.01	0.01	0.02	0.02	1/6	1
	DIELDRIN	UG/L	0.03	0.03	0.05	0.05	1/6	1
	ENDRIN	UG/L	0.03	0.03	0.05	0.05	1/6	0
	GAMMA-BHC (LINDANE)	UG/L	0.01	0.01	0.02	0.02	1/6	*
	HEPTACHLOR	UG/L	0.01	0.01	0.02	0.02	1/6	0
	TOTAL DDTs	UG/L	0.1	0.1	0.1	0.1	1/6	*
TOTAL METALS	ALUMINUM	UG/L	541	37,700	7,050	1,650	6/6	1
	ANTIMONY	UG/L	3.5	3.5	1.8	1.7	1/6	0
	ARSENIC	UG/L	9.7	9.7	2.8	1.9	1/6	1
	BARIUM	UG/L	28.7	211	65.7	48.5	6/6	0
	CALCIUM	UG/L	43,000	62,300	50,400	50,000	6/6	*
	CHROMIUM	UG/L	2.0	102	19.2	4.7	6/6	*
	COBALT	UG/L	0.64	27.6	5.4	1.7	6/6	0
	COPPER	UG/L	5.0	82.0	19.2	9.9	6/6	0
	IRON	UG/L	1,070	62,800	11,700	2,730	6/6	*
	LEAD	UG/L	57.3	57.3	10.2	1.5	1/6	1
	MAGNESIUM	UG/L	111,000	148,000	129,000	128,000	6/6	*
	MANGANESE	UG/L	31.1	582	160	94.9	6/6	1

UG/L = Micrograms per liter

MG/L = Milligrams per liter

NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures. Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.

06/07/99

Table 6-8

## R Area Disposal Site (Site 2)

Second Quarter, October 1995

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total PRG Tap Water
TOTAL METALS	MERCURY	UG/L	0.66	0.65	0.15	0.077	1/6
	MOLYBDENUM	UG/L	1.4	2.5	1.8	1.6	5/6
	NICKEL	UG/L	4.5	118	24.5	9.6	6/6
	POTASSIUM	UG/L	32,600	45,000	36,700	36,400	5/5
	SODIUM	UG/L	818,000	1,080,000	956,000	952,000	6/6
	THALLIUM	UG/L	2.4	2.4	1.2	1.1	1/6
	VANADIUM	UG/L	5.2	139	28.7	10.8	6/6
	ZINC	UG/L	346	346	76.5	34.4	1/6

UG/L = Micrograms per liter

MG/L = Milligrams per liter

NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.

Table 6-9

## R Area Disposal Site (Site 2)

Third Quarter, January 1996

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	>APFO Tap Water
SOLIDS	TOTAL SUSPENDED SOLIDS	MG/L	21	110	45	39	16/17	*
TOTAL METALS	ALUMINUM	UG/L	141	1,450	549	316	13/17	0
	ARSENIC	UG/L	1.5	3.6	2.4	2.3	15/17	15
	BARIUM	UG/L	26.2	230	67.6	51.1	17/17	0
	CADMIUM	UG/L	1.8	1.8	0.31	0.20	1/17	0
	CALCIUM	UG/L	18,500	339,000	145,000	90,500	17/17	*
	CHROMIUM	UG/L	2.4	4.2	1.4	0.67	6/17	*
	COBALT	UG/L	3.5	80.4	14.9	3.2	9/17	0
	COPPER	UG/L	6.5	17.0	9.7	8.7	15/17	0
	IRON	UG/L	292	10,900	3,060	2,040	17/17	*
	LEAD	UG/L	2.1	2.3	0.79	0.62	2/17	0
	MAGNESIUM	UG/L	24,000	543,000	182,000	118,000	17/17	*
	MANGANESE	UG/L	28.8	5,360	1,510	546	17/17	11
	MOLYBDENUM	UG/L	6.6	6.6	1.8	0.96	2/17	0
	NICKEL	UG/L	3.9	171	39.9	19.2	17/17	0
	POTASSIUM	UG/L	6,710	117,000	39,800	28,600	17/17	*
	SELENIUM	UG/L	2.4	2.5	1.6	1.4	2/17	0
	SODIUM	UG/L	147,000	3,220,000	1,130,000	756,000	17/17	*
	THALLIUM	UG/L	4.4	4.4	1.5	1.3	1/17	1
	VANADIUM	UG/L	3.8	7.5	3.0	1.6	7/17	0

UG/L = Micrograms per liter

MG/L = Milligrams per liter

NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.

06/07/99

Table 6-9

## R Area Disposal Site (Site 2)

Third Quarter, January 1996

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Unit	Detected Results			Screening Criteria
		Minimum	Maximum	Arithmetic Mean	Geometric Mean
ZINC	UG/L	19.6	234	50.4	25.0
TOTAL METALS					10/17
					0

UG/L = Micrograms per liter    MG/L = Milligrams per liter    NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.

Table 6-10

## R Area Disposal Site (Site 2)

Fourth Quarter, April - May 1996

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total ≥PRG Tap Water
SOLIDS	TOTAL SUSPENDED SOLIDS	MG/L	10	1,800	210	61	14/14
PESTICIDES	ALDRIN	UG/L	0.03	0.03	0.03	0.03	1/13
	ALPHA-BHC	UG/L	0.03	0.07	0.03	0.03	3/13
	ALPHA-CHLORDANE	UG/L	0.04	0.04	0.03	0.03	1/13
	BETA-BHC	UG/L	0.03	0.03	0.03	0.03	1/13
TOTAL METALS	HEPTACHLOR	UG/L	0.1	0.1	0.03	0.03	1/13
	HEPTACHLOR EPOXIDE	UG/L	0.01	0.04	0.008	0.006	2/13
	ALUMINUM	UG/L	47.6	3,460	815	442	14/14
	ARSENIC	UG/L	5.0	22.9	7.5	5.8	11/14
	BARIUM	UG/L	18.6	232	94.7	74.5	14/14
	CADMIUM	UG/L	0.42	8.3	1.4	0.60	8/14
	CALCIUM	UG/L	22,100	504,000	197,000	118,000	14/14
	CHROMIUM	UG/L	1.4	8.0	2.8	2.0	10/14
	COBALT	UG/L	2.2	40.4	8.7	3.0	9/14
	COPPER	UG/L	3.4	17.9	5.2	3.8	7/14
	IRON	UG/L	1,090	221,000	25,800	6,230	14/14
	LEAD	UG/L	2.9	21.2	2.5	1.2	2/14
	MAGNESIUM	UG/L	31,400	991,000	346,000	205,000	14/14
	MANGANESE	UG/L	64.1	9,030	2,350	726	14/14
	MERCURY	UG/L	0.26	0.30	0.13	0.12	2/13

UG/L = Micrograms per liter MG/L = Milligrams per liter NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.

06/07/99

Table 6-10

## R Area Disposal Site (Site 2)

Fourth Quarter, April - May 1996

## Statistical Summary of Surface Water Sample Analytical Results

Analyte	Unit	Detected Results			Screening Criteria	
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total
TOTAL METALS	MOLYBDENUM	1.7	19.8	6.0	3.5	11/14
	NICKEL	8.6	40.0	13.7	8.5	7/14
	POTASSIUM	12,600	155,000	66,200	51,400	14/14
	SELENIUM	3.9	4.1	2.1	2.0	2/14
SODIUM VANADIUM ZINC	SODIUM	240,000	5,220,000	2,000,000	1,310,000	14/14
	VANADIUM	1.8	26.1	8.1	6.2	14/14
	ZINC	9.0	59.5	19.2	13.1	11/14

UG/L = Micrograms per liter    MG/L = Milligrams per liter    NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.

Table 6-11

## Froid &amp; Taylor Site (Site 9)

First Quarter, July 1995

## Statistical Summary of Surface Water Sample Analytical Results

Analyte	Unit	Detected Results			Screening Criteria	
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total --PRG Tap Water
SOLIDS	MG/L	57	320	190	130	2/2 *
TOTAL SUSPENDED SOLIDS	MG/L					
ALUMINUM	UG/L	304	343	324	323	2/2 0
ARSENIC	UG/L	20.9	29.7	25.3	24.9	2/2 2
BARIUM	UG/L	220	221	221	220	2/2 0
CALCIUM	UG/L	231,000	314,000	273,000	269,000	2/2 *
COBALT	UG/L	3.9	4.0	4.0	3.9	2/2 0
COPPER	UG/L	9.6	12.7	11.2	11.0	2/2 0
IRON	UG/L	785	8,480	4,630	2,580	2/2 *
LEAD	UG/L	4.0	4.0	2.4	1.7	1/2 0
MAGNESIUM	UG/L	452,000	623,000	538,000	531,000	2/2 *
MANGANESE	UG/L	532	1,060	796	751	2/2 2
MERCURY	UG/L	0.13	0.17	0.15	0.15	2/2 0
POTASSIUM	UG/L	74,200	99,200	86,700	85,800	2/2 *
SODIUM	UG/L	3,400,000	4,020,000	3,710,000	3,700,000	2/2 *
VANADIUM	UG/L	10.0	15.7	12.9	12.5	2/2 0
ZINC	UG/L	95.2	95.2	58.6	45.8	1/2 0
TPH EXTRACTABLES	MG/L	0.3	0.3	0.3	0.3	2/2 *
DIESEL RANGE ORGANICS	MG/L	0.6	0.8	0.7	0.7	2/2 *
MOTOR OIL RANGE ORGANICS	MG/L					

UG/L = Micrograms per liter

MG/L = Milligrams per liter

NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.





Table 6-12

Froid &amp; Taylor Site (Site 9)

Second Quarter, October 1995

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	>100 Tap Water
SOLIDS	TOTAL SUSPENDED SOLIDS	MG/L	5,500	5,500	5,500	5,500	1/1	*
TOTAL METALS	ALUMINUM	UG/L	1,610	1,610	1,610	1,610	1/1	0
	ANTIMONY	UG/L	9.9	9.9	9.9	9.9	1/1	0
	ARSENIC	UG/L	275	275	275	275	1/1	1
	BARIUM	UG/L	809	809	809	809	1/1	0
	CALCIUM	UG/L	1,950,000	1,950,000	1,950,000	1,950,000	1/1	*
	CHROMIUM	UG/L	6.9	6.9	6.9	6.9	1/1	*
	COBALT	UG/L	5.1	5.1	5.1	5.1	1/1	0
	COPPER	UG/L	10.8	10.8	10.8	10.8	1/1	0
	IRON	UG/L	3,230	3,230	3,230	3,230	1/1	*
	MAGNESIUM	UG/L	5,280,000	5,280,000	5,280,000	5,280,000	1/1	*
TPH EXTRACTABLES	MANGANESE	UG/L	4,480	4,480	4,480	4,480	1/1	1
	MOLYBDENUM	UG/L	1.3	1.3	1.3	1.3	1/1	0
	NICKEL	UG/L	44.7	44.7	44.7	44.7	1/1	0
	POTASSIUM	UG/L	552,000	552,000	552,000	552,000	1/1	*
	SODIUM	UG/L	28,300,000	28,300,000	28,300,000	28,300,000	1/1	*
	THALLIUM	UG/L	8.4	8.4	8.4	8.4	1/1	1
	VANADIUM	UG/L	29.8	29.8	29.8	29.8	1/1	0
	DIESEL RANGE ORGANICS	MG/L	2	2	2	2	1/1	*

UG/L = Micrograms per liter MG/L = Milligrams per liter NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.

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Table 6-12

Froid &amp; Taylor Site (Site 9)

Second Quarter, October 1995

## Statistical Summary of Surface Water Sample Analytical Results

Analyte	Unit	Detected Results			Screening Criteria	
		Minimum	Maximum	Arithmetic Mean	Conductivity Total	Tap Water
TPH EXTRACTABLES	MG/L	2	2	2	1/1	*
VOLATILES	UG/L	20	20	20	1/1	0

UG/L = Micrograms per liter MG/L = Milligrams per liter NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures. Preliminary remediation goals (PRG) for tap water (EPA 1995).

\* Screening values not available.

Table 6-13

Froid &amp; Taylor Site (Site 9)

Third Quarter, January 1996

## Statistical Summary of Surface Water Sample Analytical Results

Analyte	Unit	Detected Results			Screening Criteria	
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total
SOLIDS	MG/L	15	15	13	12	1/2
TOTAL SUSPENDED SOLIDS	MG/L	2.2	3.0	2.6	2.6	2/2
ARSENIC	UG/L	106	115	111	110	2/2
BARIUM	UG/L	68,800	182,000	125,000	112,000	2/2
CALCIUM	UG/L	7.8	13.4	10.6	10.2	2/2
COPPER	UG/L	186	477	312	298	2/2
IRON	UG/L	55,700	209,000	132,000	108,000	2/2
MAGNESIUM	UG/L	207	310	259	253	2/2
MANGANESE	UG/L	4.6	4.6	3.1	2.8	1/2
MOLYBDENUM	UG/L	3.8	9.1	6.5	5.9	2/2
NICKEL	UG/L	14,800	41,000	27,900	24,600	2/2
POTASSIUM	UG/L	2.4	2.4	1.8	1.7	1/2
SELENIUM	UG/L	485,000	1,360,000	923,000	812,000	2/2
SODIUM	UG/L	0.08	0.1	0.1	0.1	2/2
DIESEL RANGE ORGANICS	MG/L	0.1	0.2	0.1	0.1	2/2
MOTOR OIL RANGE ORGANICS	MG/L	0.1	0.2	0.1	0.1	2/2
TPH EXTRACTABLES	MG/L	0.1	0.2	0.1	0.1	2/2

UG/L = Micrograms per liter

MG/L = Milligrams per liter

NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.



Table 6-14

Froid &amp; Taylor Site (Site 9)

Fourth Quarter, April - May 1996

## Statistical Summary of Surface Water Sample Analytical Results

Analyte	Unit	Detected Results				Screening Criteria	
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	>=PRG Tap Water
SOLIDS	MG/L	23	23	23	23	1/1	*
TOTAL SUSPENDED SOLIDS	MG/L	23	23	23	23	1/1	*
ALUMINUM	UG/L	116	116	116	116	1/1	0
ARSENIC	UG/L	10.0	10.0	10.0	10.0	1/1	1
BARIUM	UG/L	159	159	159	159	1/1	0
CADMIUM	UG/L	1.1	1.1	1.1	1.1	1/1	0
CALCIUM	UG/L	185,000	185,000	185,000	185,000	1/1	*
CHROMIUM	UG/L	1.7	1.7	1.7	1.7	1/1	*
COBALT	UG/L	2.3	2.3	2.3	2.3	1/1	0
IRON	UG/L	1,830	1,830	1,830	1,830	1/1	*
MAGNESIUM	UG/L	239,000	239,000	239,000	239,000	1/1	*
MANGANESE	UG/L	585	585	585	585	1/1	1
MOLYBDENUM	UG/L	2.3	2.3	2.3	2.3	1/1	0
POTASSIUM	UG/L	61,700	61,700	61,700	61,700	1/1	*
SODIUM	UG/L	1,600,000	1,600,000	1,600,000	1,600,000	1/1	*
VANADIUM	UG/L	4.1	4.1	4.1	4.1	1/1	0
MOTOR OIL RANGE ORGANICS	MG/L	0.6	0.6	0.6	0.6	1/1	*
TPH EXTRACTABLES	MG/L	0.6	0.6	0.6	0.6	1/1	*

UG/L = Micrograms per liter MG/L = Milligrams per liter NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.



Table 6-15

Froid &amp; Taylor Site (Site 9)

Final Sampling Event, June 1998

## Statistical Summary of Surface Water Sample Analytical Results

Analyte	Analyte	Unit	Detected Results			Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total
SEMIVOLATILES	4-METHYLPHENOL	UG/L	3	3	5	4	1/3
	CHRYSENE	UG/L	0.6	0.6	4	2	1/3
	HIGH MOLECULAR PAHs	UG/L	45	45	45	45	1/3
TOTAL METALS	PHENOL	UG/L	0.9	0.9	4	3	1/3
	TOTAL PAHs	UG/L	72	72	71	71	1/3
	ALUMINUM	UG/L	446	461	335	272	2/3
	ANTIMONY	UG/L	1.0	1.0	0.67	0.63	1/3
	ARSENIC	UG/L	12.2	12.5	12.4	12.4	3/3
	BARIUM	UG/L	220	253	238	238	3/3
	CALCIUM	UG/L	86,200	190,000	152,000	144,000	3/3
	COBALT	UG/L	1.2	1.8	1.6	1.5	3/3
	COPPER	UG/L	2.9	3.8	3.4	3.4	3/3
	IRON	UG/L	2,350	3,050	2,800	2,780	3/3
	MAGNESIUM	UG/L	99,100	263,000	204,000	187,000	3/3
	MANGANESE	UG/L	452	1,740	948	801	3/3
	MOLYBDENUM	UG/L	0.92	1.1	0.99	0.99	3/3
	NICKEL	UG/L	5.3	11.9	9.5	8.9	3/3
	POTASSIUM	UG/L	32,200	60,800	50,300	48,400	3/3
	SELENIUM	UG/L	1.0	2.3	1.5	1.4	3/3
	SILVER	UG/L	0.27	0.30	0.23	0.22	2/3

UG/L = Micrograms per liter MG/L = Milligrams per liter NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.



Table 6-15

Froid &amp; Taylor Site (Site 9)

Final Sampling Event, June 1998

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	PRG Tap Water
TOTAL METALS	SODIUM	UG/L	859,000	1,830,000	1,470,000	1,400,000	3/3
	VANADIUM	UG/L	5.5	7.0	6.3	6.3	3/3
	ZINC	UG/L	21.9	21.9	10.5	7.9	1/3

UG/L = Micrograms per liter    MG/L = Milligrams per liter    NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

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Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.

Table 6-16

## Wood Hogger Site (Site 11)

First Quarter, July 1995

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	MSBQ Tap Water
SOLIDS	TOTAL SUSPENDED SOLIDS	MG/L	9	20	13	12	5/6	*
TOTAL METALS	ALUMINUM	UG/L	167	294	173	148	4/6	0
	BARIUM	UG/L	46.7	94.5	66.1	63.9	6/6	0
	CALCIUM	UG/L	40,000	56,400	45,900	45,600	6/6	*
	COBALT	UG/L	0.52	1.0	0.57	0.50	4/6	0
	COPPER	UG/L	9.5	11.6	5.5	4.5	2/6	0
	IRON	UG/L	395	1,500	859	799	6/6	*
	LEAD	UG/L	2.8	2.8	1.1	0.93	1/6	0
	MAGNESIUM	UG/L	80,200	113,000	98,600	98,100	6/6	*
	MANGANESE	UG/L	44.6	330	207	172	6/6	4
	POTASSIUM	UG/L	23,400	34,900	30,300	30,100	6/6	*
VOLATILES	SODIUM	UG/L	654,000	910,000	806,000	802,000	6/6	*
	ZINC	UG/L	53.9	329	94.2	58.9	4/6	0
	XYLENE (TOTAL)	UG/L	8	8	6	5	1/6	*

UG/L = Micrograms per liter MG/L = Milligrams per liter NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.



Table 6-17

## Wood Hogger Site (Site 11)

Second Quarter, October 1995

## Statistical Summary of Surface Water Sample Analytical Results

Analyte	Unit	Detected Results				Screening Criteria	
		Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total	Tap Water
SOLIDS	MG/L	25	140	50	41	6/6	*
TOTAL SUSPENDED SOLIDS	MG/L						
ALUMINUM	UG/L	281	1,510	615	421	5/6	0
ANTIMONY	UG/L	3.6	3.6		1.7	1/6	0
BARIUM	UG/L	33.0	173	81.3	69.8	6/6	0
CALCIUM	UG/L	43,300	87,700	63,100	61,400	5/6	*
CHROMIUM	UG/L	0.63	4.8	1.7	1.2	5/6	*
COBALT	UG/L	0.59	1.4	0.96	0.92	6/6	0
COPPER	UG/L	4.3	7.7	5.6	5.5	6/6	0
IRON	UG/L	537	3,240	1,380	1,120	6/6	*
MAGNESIUM	UG/L	115,000	268,000	169,000	163,000	6/6	*
MANGANESE	UG/L	47.8	278	156	136	6/6	2
MOLYBDENUM	UG/L	1.3	3.0	1.7	1.5	5/6	0
NICKEL	UG/L	3.0	7.6	4.7	4.5	6/6	0
POTASSIUM	UG/L	33,400	73,300	48,400	46,900	6/6	*
SODIUM	UG/L	891,000	2,200,000	1,350,000	1,300,000	6/6	*
THALLIUM	UG/L	2.4	2.4	1.4	1.3	2/6	0
VANADIUM	UG/L	5.1	9.7	4.8	3.6	4/6	0
ZINC	UG/L	150	150	44.9	28.7	1/6	0

UG/L = Micrograms per liter MG/L = Milligrams per liter NA = Not Analyzed

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Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.



Table 6-18

## Wood Hogger Site (Site 11)

Third Quarter, January 1996

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total -PWS Tap Water
SOLIDS	TOTAL SUSPENDED SOLIDS	MG/L	17	28	20	19	5/6
TOTAL METALS	ALUMINUM	UG/L	166	1,430	843	625	6/6
	ARSENIC	UG/L	2.1	2.7	2.5	2.4	6/6
	BARIUM	UG/L	25.5	130	49.6	41.4	6/6
	CALCIUM	UG/L	19,400	108,000	43,100	36,100	6/6
	CHROMIUM	UG/L	3.9	4.1	2.3	1.5	3/6
	COBALT	UG/L	0.56	0.56	0.46	0.45	1/6
	COPPER	UG/L	5.3	11.6	5.6	5.6	5/6
	IRON	UG/L	583	2,460	1,580	1,380	6/6
	LEAD	UG/L	1.3	3.1	1.4	1.1	3/6
	MAGNESIUM	UG/L	33,700	155,000	68,900	60,600	6/6
	MANGANESE	UG/L	64.3	469	185	127	6/6
	NICKEL	UG/L	2.6	6.1	4.7	4.5	6/6
	POTASSIUM	UG/L	10,700	29,300	18,300	17,400	6/6
	SODIUM	UG/L	252,000	989,000	502,000	457,000	6/6
	VANADIUM	UG/L	5.1	7.5	4.6	3.4	4/6
	ZINC	UG/L	31.5	110	32.1	16.6	3/6
							6/6
							6/6
							4/6
							3/6
							0

UG/L = Micrograms per liter MG/L = Milligrams per liter NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

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Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.



Table 6-19

## Wood Hogger Site (Site 11)

Fourth Quarter, April - May 1996

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results				Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Results	>100 Tap Water
SOLIDS	TOTAL SUSPENDED SOLIDS	MG/L	21	54	38	36	6/6	*
TOTAL METALS	ALUMINUM	UG/L	332	2,100	1,030	894	6/6	0
	ANTIMONY	UG/L	2.6	2.6	1.4	1.3	1/6	0
	ARSENIC	UG/L	4.1	11.8	4.3	3.3	3/6	3
	BARIUM	UG/L	56.6	119	80.6	77.3	6/6	0
	CADMIUM	UG/L	0.44	2.5	0.79	0.56	5/6	0
	CALCIUM	UG/L	40,700	51,500	45,600	45,400	6/6	*
	CHROMIUM	UG/L	1.5	6.1	3.3	2.9	6/6	*
	COBALT	UG/L	1.2	1.2	0.66	0.63	1/6	0
	COPPER	UG/L	3.0	13.7	5.9	4.8	5/6	0
	IRON	UG/L	1,530	3,300	2,260	2,180	6/6	*
	LEAD	UG/L	3.7	3.7	1.1	0.83	1/6	0
	MAGNESIUM	UG/L	70,900	129,000	88,600	86,700	6/6	*
	MANGANESE	UG/L	157	1,950	486	279	6/6	3
	MERCURY	UG/L	0.20	0.24	0.14	0.13	2/6	0
	MOLYBDENUM	UG/L	7.3	7.3	2.2	1.5	1/6	0
	NICKEL	UG/L	5.5	7.1	5.5	5.1	5/6	0
	POTASSIUM	UG/L	28,800	58,100	36,400	35,300	6/6	*
	SODIUM	UG/L	587,000	1,250,000	747,000	719,000	6/6	*
	VANADIUM	UG/L	5.1	11.3	8.8	8.5	6/6	0

UG/L = Micrograms per liter    MG/L = Milligrams per liter    NA = Not Analyzed  
 The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

Organic results less than 10 are reported to one significant figure, and results greater than 10 are reported to two significant figures.

Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.



Table 6-19

## Wood Hogger Site (Site 11)

Fourth Quarter, April - May 1996

## Statistical Summary of Surface Water Sample Analytical Results

Analysis	Analyte	Unit	Detected Results			Screening Criteria	
			Minimum	Maximum	Arithmetic Mean	Geometric Mean	Total
TOTAL METALS	ZINC	UG/L	12.7	318	68.9	24.9	5/5
							0

UG/L = Micrograms per liter    MG/L = Milligrams per liter    NA = Not Analyzed

The minimum and the maximum results, and the arithmetic and geometric means were calculated using the detected values.

The Total column shows the ratio of the number of the analyte detected to the number of the analyte analyzed.

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Inorganic results less than 10 are reported to two significant figures, and results greater than 10 are reported to three significant figures.

Preliminary remediation goals (PRG) for tap water (EPA 1996).

\* Screening values not available.

TABLE 6-19

ANALYSES PERFORMED ON 1998 RI AND QEA SAMPLES  
TIDAL AREA, NWS CONCORD

Matrix	Sample Location	Inorganics		Organics			Other parameters				Biological Tests			
		Metals	SVOC	Pesticides/ PCBs	Chlordane	Low Level Pesticides/ PCBs	Dioxins	TOC	pH	SEM/AVS	Grain Size	Amphipod Bioassay	Topsmelt Bioassay	
Soil (0-0.5 ft.)	Site 9 - Froid and Taylor Roads Site													
	FTSSB100	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	
	FTSSB101	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	
	Site 11 - Wood Hogger													
	WHSSB009	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
	WHSSB010	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
	WHSSB016	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
	WHSSB008	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
	WHSSB017	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
	WHSSB019	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
	WHSS007	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
	WHSSB023	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
	WHSSB018	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	
	Soil Sample Total:	0	0	0	2	0	9	0	0	0	0	0	0	
Sediment (0-0.5ft.)	Site 9 - Froid and Taylor Roads Site													
	FTSSL102	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	FTSSL103	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	FTSSL104	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Surface Water	Otter Sluice													
	OSLSL001	1	1	NA	NA	1	NA	1	1	1	1	1	1	
	OSLSL002	1	1	NA	NA	1	NA	1	1	1	1	1	1	
	OSLSL003	1	1	NA	NA	1	NA	1	1	1	1	1	1	
	OSLSL004	1	1	NA	NA	1	NA	1	1	1	1	1	1	
	OSLSL005	1	1	NA	NA	1	1	1	1	1	1	1	1	
	OSLSL006	1	1	NA	NA	1	1	1	1	1	1	1	1	
	OSLSL007	1	1	NA	NA	1	1	1	1	1	1	1	1	
	OSLSL008	1	1	NA	NA	1	1	1	1	1	1	NA	NA	
	OSLSL009	1	1	NA	NA	1	NA	1	1	1	1	NA	NA	
	Sediment Sample Total:	12	12	3	0	9	4	9	9	9	9	7	7	
	Site 9 - Froid and Taylor Roads Site													
	FTSSL102	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	FTSSL103	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	
FTSSL104	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Otter Sluice														
OSLSL001	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA		
OSLSL002	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA		
OSLSL003	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA		
OSLSL004	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA		
OSLSL005	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA		
OSLSL006	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA		
OSLSL007	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA		
OSLSL008	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA		
OSLSL009	1	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Surface Water Sample Total:	12	12	12	0	0	0	0	0	0	0	0	0		

TABLE 6-19

**ANALYSES PERFORMED ON 1998 RI AND QEA SAMPLES  
TIDAL AREA, NWS CONCORD**

		Inorganics		Organics			Other parameters					Biological Tests	
Matrix	Sample Location	Metals	SVOC	Pesticides/ PCBs	Chlordane	Low Level Pesticides/ PCBs	Dioxins	TOC	pH	SEM/AVS	Grain Size	Amphipod Bioassay	Topsmelt Bioassay
Fish Tissue	Site 9 - Froid and Taylor Roads Site												
	FTST1105	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Otter Sluice												
	OSL.SL.002	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	OSL.SL.004	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	OSL.SL.005	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
	OSL.SL.006	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
	OSL.SL.007	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
	Fish Tissue Sample Total:	6	0	1	0	5	2	0	0	0	0	0	0
	Clam Tissue												
Otter Sluice													
OSL.SL.002	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
OSL.SL.004	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
OSL.SL.005	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
OSL.SL.006	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
OSL.SL.007	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
Clam Tissue Sample Total:	5	0	0	0	0	5	2	0	0	0	0	0	0
Amphipod Tissue													
Site 9 - Froid and Taylor Roads Site													
FTST1105	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Amphipod Tissue Sample Total:	1	1	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pickleweed Tissue													
Site 2 - R Area Disposal													
RADT1501	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RADT1502	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RADT1503	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Site 11 - Wood Hogger													
WHS11509	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pickleweed Tissue Sample Total:	4	0	0	0	0	0	0	0	0	0	0	0	0
Rodent Tissue													
Site 2 - R Area Disposal													
RAC1 (composite)	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
RAC2 (composite)	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
RAC3 (composite)	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
Site 11 - Wood Hogger													
WHC1 (composite)	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
WHC2 (composite)	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
WHC3 (composite)	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA
Rodent Tissue Sample Total:	6	0	0	0	0	6	3	0	0	0	0	0	0

Notes:

NA Not analyzed  
 SEM/AVS Simultaneously Extractable Metals / Acid Volatile Sulfide  
 SVOC Semivolatile organic compound  
 TOC Total organic carbon

TABLE 7-1

**EXPOSURE DOSE EQUATIONS AND EXPOSURE FACTOR VALUES  
DERMAL CONTACT WITH SURFACE WATER  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

$\text{LADD}^a(\text{mg/kg-d}) = \frac{C_{\text{water}} \times \text{SA} \times \text{PC} \times \text{ET} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{At}_{\text{carc}}}$	
$\text{ADD}^b(\text{mg/kg-d}) = \frac{C_{\text{water}} \times \text{SA} \times \text{PC} \times \text{ET} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{At}_{\text{non}}}$	
Exposure Factor (units)	Exposure Value
$C_{\text{water}}$ = Contaminant concentration in water (mg/liter)	UCL <sub>95</sub> or Maximum Detection <sup>c</sup>
SA = Skin surface area available for contact (cm <sup>2</sup> )	
Residential user - adult	5,700 <sup>d</sup>
Residential user - child	2,900 <sup>d</sup>
Industrial Worker	5,700 <sup>d</sup>
PC = Chemical-specific dermal permeability constant (cm/hr)	Chemical-specific
ET = Exposure time (hours/day)	2 <sup>e</sup>
EF = Exposure frequency (days/year)	
Residential user - adult	52 <sup>e</sup>
Residential user - child	52 <sup>e</sup>
Industrial Worker	52 <sup>e</sup>
ED = Exposure duration (years)	
Residential user - adult	24 <sup>d</sup>
Residential user - child	6 <sup>d</sup>
Industrial Worker	25 <sup>d</sup>
CF = Volumetric conversion factor for water (L/cm <sup>3</sup> )	0.001
BW = Body weight (kg)	
Residential user - adult	70 <sup>d</sup>
Residential user - child	15 <sup>d</sup>
Industrial Worker	70 <sup>d</sup>
AT <sub>carc</sub> = Averaging time for carcinogens (days)	25,550 <sup>d</sup>
AT <sub>non</sub> = Averaging time for noncarcinogens (days)	ED (years) x 365 days/year

## Notes:

- a LADD - Lifetime average daily dose, which is the intake value used to evaluate potential cancer risk.
- b ADD - Average daily dose, which is the intake value used to evaluate potential adverse noncancer risk.
- c UCL<sub>95</sub> - The 95 percent upper confidence limit of the arithmetic mean or the maximum detected concentration (whichever is lower) will be used for the reasonable maximum exposure (RME) case.
- d U.S. Environmental Protection Agency - 1998.
- e Based on professional judgment, representing exposure to surface water 1 day per week and each exposure lasting for 2 hours.



TABLE 7-2

**PRELIMINARY REMEDIATION GOALS  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Chemical of Potential Concern	Preliminary Remediation Goals <sup>a</sup>					
	Soil (mg/kg)				Tap Water (µg/L)	
	Residential		Industrial		Residential	
	Cancer	Noncancer	Cancer	Noncancer	Cancer	Noncancer
<b>Metals</b>						
Aluminum	--	75,000	--	1,900,000 <sup>b</sup>	--	37,000
Antimony	--	30	--	750	--	15
Arsenic	0.38	21	3.0	480	0.045	11
Barium	--	5,200	--	120,000 <sup>b</sup>	--	2,600
Beryllium	--	150	--	3,400	--	73
Cadmium	9.0 <sup>c</sup>	37	3,000	930	--	18
Hexavalent chromium	0.2 <sup>c</sup>	370	64	9,400	0.16 <sup>c</sup>	180
Chromiumd	210	--	450	--	--	--
Cobalt	--	3,300	--	29,000	--	2,200
Copper	--	2,800	--	70,000	--	1,400
Iron	--	22,000	--	560,000 <sup>b</sup>	--	11,000
Lead	--	130 <sup>c</sup>	--	1,000	--	4.0
Manganese	--	3,100	--	45,000	--	1,700
Mercury	--	22	--	560	--	11
Molybdenum	--	370	--	9,400	--	180
Nickel	150 <sup>c</sup>	1,500	--	37,000	--	730
Selenium	--	370	--	9,400	--	180
Silver	--	370	--	9,400	--	180
Thallium (thallous oxide)	--	5.2	--	130	--	2.6
Vanadium	--	520	--	13,000	--	260
Zinc	--	22,000	--	560,000 <sup>b</sup>	--	11,000
<b>Volatile Organic Compound</b>						
Acetone	--	1,400	--	6,100	--	610
2-Butanone (methyl ethyl ketone)	--	6,900	--	27,000	--	1,900
Carbon Disulfide	--	350	--	1,200	--	1,000
Chloromethane	1.2	--	2.6	--	1.5	--
Ethylbenzene	--	1,400	--	5,800	--	1,300
4-Methyl-2-pentanone	--	750	--	2,800	--	160
Xylene (total)	--	1,300 <sup>b</sup>	--	4,500 <sup>b</sup>	--	1,400
<b>Semivolatile Organic Compound</b>						
1,1'-Biphenyl	--	2,300	--	24,000	--	300
1-Methylnaphthalene <sup>d</sup>	--	55	--	190	--	6.2
1-Methylphenanthrene <sup>d</sup>	--	55	--	190	--	6.2
2,4-Dimethylphenol	--	1,100	--	21,000	--	730
2,6-Dimethylnaphthalene <sup>d</sup>	--	55	--	190	--	6.2
2-Methylnaphthalene <sup>d</sup>	--	55	--	190	--	6.2
4-Methylphenol	--	270	--	5,300	--	180
Acenaphthene	--	2,600	--	28,000	--	370
Acenaphthylene <sup>e</sup>	--	2,600	--	28,000	--	370
Anthracene	--	14,000	--	220,000 <sup>b</sup>	--	1,800
Benzo(a)anthracene	0.56	--	3.6	--	0.092	--
Benzo(a)pyrene	0.056	--	0.36	--	0.0015 <sup>c</sup>	--
Benzo(b)fluoranthene	0.56	--	3.6	--	0.092	--
Benzo(e)pyrene <sup>h</sup>	--	1,500	--	26,000	--	180
Benzo(g,h,i)perylene <sup>h</sup>	--	1,500	--	26,000	--	180
Benzo(k)fluoranthene	0.61 <sup>c</sup>	--	36	--	0.92	--
Benzoic acid	--	220,000 <sup>b</sup>	--	4,300,000 <sup>b</sup>	--	150,000
Bis(2-ethylhexyl)phthalate	32	1,100	210	21,000	4.8	730
Bis(2-benzyl)phthalate	--	11,000 <sup>b</sup>	--	210,000 <sup>b</sup>	--	7,300
Carbazole	22	--	150	--	3.4	--
Chrysene	6.1 <sup>c</sup>	--	360	--	9.2	--
Dibenz(a,h)anthracene	0.056	--	0.36	--	0.0092	--
Dibenzofuran	--	210	--	3,200	--	24

TABLE 7-2

**PRELIMINARY REMEDIATION GOALS  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Chemical of Potential Concern	Preliminary Remediation Goals <sup>a</sup>					
	Soil (mg/kg)				Tap Water (µg/L)	
	Residential		Industrial		Residential	
	Cancer	Noncancer	Cancer	Noncancer	Cancer	Noncancer
<b>Semivolatile Organic Compound (Continued)</b>						
Dibenzothiophene	--	--	--	--	--	--
Diethylphthalate	--	44,000	--	860,000 <sup>b</sup>	--	29,000
Fluoranthene	--	2,000	--	37,000	--	1,500
Fluorene	--	1,800	--	22,000	--	240
Indeno(1,2,3-cd)pyrene	0.56	--	3.6	--	0.092	--
Isophorone	470	11,000	3,200	210,000 <sup>b</sup>	71	7,300
Naphthalene	--	55	--	190	--	6.2
Pentachlorophenol	2.5	1,100	15	19,000	0.56	1,100
Perylene <sup>c</sup>	--	55	--	190	--	6.2
Phenanthrene <sup>c</sup>	--	55	--	190	--	6.2
Phenol	--	33,000	--	640,000 <sup>b</sup>	--	22,000
Pyrene	--	1,500	--	26,000	--	180
<b>Pesticide/Polychlorinated Biphenyl</b>						
2,4'-DDD	2.4	--	19	--	0.28	--
2,4'-DDE	1.7	--	13	--	0.20	--
2,4'-DDT	1.7	35	13	800	0.20	18
4,4'-DDD	2.4	--	19	--	0.28	--
4,4'-DDE	1.7	--	13	--	0.20	--
4,4'-DDT	1.7	35	13	800	0.20	18
Aldrin	0.026	1.6	0.18	32	0.0040	1.1
alpha-BHC	0.086	--	0.67	--	0.011	--
alpha-Chlordane <sup>c</sup>	1.6	33	12	750	0.19	18
beta-BHC	0.3	--	2.3	--	0.037	--
Dieldrin	0.028	2.7	0.19	53	0.0042	1.8
Endrin	--	16	--	320	--	11
Endrin ketone <sup>c</sup>	--	16	--	320	--	11
gamma-BHC (lindane)	0.42	20	3.2	450	0.052	11
gamma-Chlordane <sup>c</sup>	1.6	33	12	750	0.19	18
Heptachlor	0.099	27	0.67	530	0.015	18
Heptachlor epoxide	0.049	0.71	0.33	14	0.0074	0.47
Hexachlorobenzene	0.28	44	1.9	860	0.042	29
Mirex	0.25	11	1.7	210	0.037	7.3
PCB-101 (2,2',3,5,5')	0.20	--	1.3	--	0.034	--
PCB-105 (2,3,3',4,4')	0.20	--	1.3	--	0.034	--
PCB-118 (2,3',4,4',5)	0.20	--	1.3	--	0.034	--
PCB-126 (3,3',4,4',5)	0.20	--	1.3	--	0.034	--
PCB-128 (2,2',3,3',4,4')	0.20	--	1.3	--	0.034	--
PCB-138 (2,2',3,4,4',5')	0.20	--	1.3	--	0.034	--
PCB-153 (2,2',4,4',5,5')	0.20	--	1.3	--	0.034	--
PCB-170 (2,2',3,3',4,4',5)	0.20	--	1.3	--	0.034	--
PCB-18 (2,2',5)	0.20	--	1.3	--	0.034	--
PCB-180 (2,2',3,4,4',5,5')	0.20	--	1.3	--	0.034	--
PCB-187 (2,2',3,4',5,5',6)	0.20	--	1.3	--	0.034	--
PCB-195 (2,2',3,3',4,4',5,6)	0.20	--	1.3	--	0.034	--
PCB-206 (2,2',3,3',4,4',5,5',6)	0.20	--	1.3	--	0.034	--
PCB-209 (2,2',3,3',4,4',5,5',6,6')	0.20	--	1.3	--	0.034	--
PCB-28 (2,4,4')	0.20	--	1.3	--	0.034	--
PCB-44 (2,2',3,5')	0.20	--	1.3	--	0.034	--
PCB-52 (2,2',5,5')	0.20	--	1.3	--	0.034	--
PCB-66 (2,3',4,4')	0.20	--	1.3	--	0.034	--
PCB-77 (3,3',4,4')	0.20	--	1.3	--	0.034	--
PCB-8 (2,4')	0.20	--	1.3	--	0.034	--
Technical chlordane <sup>c</sup>	1.6	33	12	750	0.19	18
trans-Nonachlor <sup>c</sup>	1.6	33	12	750	0.19	18

TABLE 7-2

**PRELIMINARY REMEDIATION GOALS  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Chemical of Potential Concern	Preliminary Remediation Goals <sup>a</sup>					
	Soil (mg/kg)				Tap Water (µg/L)	
	Residential		Industrial		Residential	
	Cancer	Noncancer	Cancer	Noncancer	Cancer	Noncancer
Dioxin/Furan						
2,3,7,8-TCDD TEQ	0.0000038	--	0.00003	--	0.00000045	--
Explosive						
1,3-Dinitrobenzene	--	5.5	--	110	--	3.7
HMX	--	2,700	--	53,000	--	1,800

## Notes:

BHC	Hexachlorocyclohexane
DDD	Dichlorodiphenyldichloroethane
DDF	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
HMX	Cyclotetramethylene tetranitramine
mg/kg	Milligram per kilogram
PCB	Polychlorinated biphenyl
TCDD	Tetrachlorodibenzodioxin
TEQ	Toxic equivalent
µg/l.	Microgram per liter

- a Preliminary remediation goals (PRG) are from the published and electronic versions of the U. S. Environmental Protection Agency (EPA) Region IX Preliminary Remediation Goals (EPA 1998).
- b The PRG for this chemical of potential concern (COPC) is the risk-based PRG rather than the "sat" or "max" value. The soil saturation ("sat") limit corresponds to the contaminant concentration in soil at which the adsorptive limits of the soil particles and the solubility limits of the soil particles and the solubility limits of the available soil moisture have been reached. The "max" is a nonrisk-based ceiling limit concentration given for relatively less toxic inorganic and semivolatile contaminants.
- c The cancer PRG for this COPC is the Cal-modified PRG and is calculated using toxicity values (slope factors) from the California Environmental Protection Agency (Cal/EPA).
- d The PRGs for total chromium assume a 1:6 ratio of hexavalent chromium to trivalent chromium (see also hexavalent chromium).
- e The PRG for lead is from the blood-lead model developed by Cal/EPA Department of Toxic Substances Control.
- f Toxicity values and PRGs not available; the PRG values for naphthalene were used as surrogate values for these compounds.
- g Toxicity values and PRGs not available; the PRG values for acenaphthene were used as surrogate values for this compound.
- h Toxicity values and PRGs not available; the PRG values for pyrene were used as surrogate values for these compounds.
- i Toxicity values and PRGs not available; the PRG values for chlordane were used as surrogate values for these compounds.
- j Toxicity values and PRGs not available; the PRG values for endrin were used as surrogate values for this compound.
- k Trans-nonachlor is a major constituent of chlordane, so the PRG values for chlordane are used for this compound.





TABLE 7-3

**NONCARCINOGENIC CRITICAL EFFECTS FOR CHEMICALS OF POTENTIAL CONCERN  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Chemical of Potential Concern <sup>a</sup>	Critical Effect or Site of Critical Effect <sup>b</sup>	CV	Blood	CNS/ PNS	Kidney	GI	Liver	Resp	Skin	Body Wt	Repro	Other
<b>Metal</b>												
Aluminum	CNS and PNS effects			✓								✓
Antimony	Reduced lifespan, altered blood chemistry		✓									
Arsenic	Hyperpigmentation, keratosis, possible vascular effects	✓							✓			
Barium	Increased blood pressure	✓										
Beryllium	No observed effect											
Cadmium	Proteinuria				✓							
Chromium (hexavalent)	No observed effect											
Cobalt	Effects on blood and respiratory system <sup>c</sup>		✓					✓				
Copper	Irritation of the GI tract					✓						
Lead												
Manganese	CNS effects			✓								
Mercury	Neurotoxicity			✓								
Molybdenum	Increased uric acid levels				✓							
Nickel	Decreased body and organ weights									✓		
Selenium	Selenosis			✓			✓		✓			
Silver	Argyria								✓			

TABLE 7-3 (Continued)

**NONCARCINOGENIC CRITICAL EFFECTS FOR CHEMICALS OF POTENTIAL CONCERN  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Chemical of Potential Concern <sup>a</sup>	Critical Effect or Site of Critical Effect <sup>b</sup>	CV	Blood	CNS/ PNS	Kidney	GI	Liver	Resp	Skin	Body Wt	Repro	Other
<b>Metal (Continued)</b>												
Thallium	Alopecia, lacrimation, exophthalmos								✓			✓
Vanadium	No observed effect											
Zinc	Anemia, decrease in erythrocyte superoxide dismutase		✓									
<b>Volatile Organic Compound</b>												
Acetone	Increased liver and kidney weights, nephrotoxicity				✓		✓					
2-Butanone	Decreased fetal birth weight										✓	
Carbon disulfide	Fetal toxicity and malformations; PNS dysfunction <sup>c</sup>			✓							✓	
Ethylbenzene	Liver and kidney toxicity, developmental toxicity <sup>c</sup>				✓		✓				✓	
4-Methyl-2-pentanone	Increased liver and kidney weights				✓		✓					
Xylene	Hyperactivity, decreased body weight, increased mortality			✓						✓		✓
<b>Semivolatile Organic Compound</b>												
1,1'-Biphenyl	--											
1-Methylnaphthalene	--											
1-Methylphenanthrene	--											

TABLE 7-3 (Continued)

**NONCARCINOGENIC CRITICAL EFFECTS FOR CHEMICALS OF POTENTIAL CONCERN  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Chemical of Potential Concern <sup>a</sup>	Critical Effect or Site of Critical Effect <sup>b</sup>	CV	Blood	CNS/ PNS	Kidney	GI	Liver	Resp	Skin	Body Wt	Repro	Other
<b>Semivolatile Organic Compound (Continued)</b>												
2,4-Dimethylphenol	Lethargy, prostration, ataxia, hematological changes		✓	✓								
2,6-Dimethylnaphthalene	--											
2-Methylnaphthalene	--											
4-Methylphenol	Hypoactivity, respiratory distress, and maternal death			✓			✓	✓				✓
Acenaphthene	Hepatotoxicity						✓					
Acenaphthylene	--											
Anthracene	No observed effect											
Benzo(e)pyrene	--											
Benzo(g,h,i)perylene	--											
Benzoic acid	No observed effect											
Bis(2-ethylhexyl) phthalate	Increased liver weight						✓					
Butylbenzylphthalate	Increased liver weight						✓					
Dibenzofuran	--											
Diethylphthalate	Decreased growth rates and food consumption, altered organ weights									✓		✓
Fluoranthene	Increased liver weight, kidney and blood effects		✓		✓		✓					
Fluorene	Decrease in red blood cells		✓									

TABLE 7-3 (Continued)

**NONCARCINOGENIC CRITICAL EFFECTS FOR CHEMICALS OF POTENTIAL CONCERN  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Chemical of Potential Concern <sup>a</sup>	Critical Effect or Site of Critical Effect <sup>b</sup>	CV	Blood	CNS/ PNS	Kidney	GI	Liver	Resp	Skin	Body Wt	Repro	Other
<b>Semivolatile Organic Compound (Continued)</b>												
Isophorone	No observed effect											
Naphthalene	--											
Pentachlorophenol	Liver/kidney pathology				✓		✓					
Perylene	--											
Phenanthrene	--											
Phenol	Decreased fetal body weight										✓	
Pyrene	Kidney effects				✓							
<b>Pesticide/Polychlorinated Biphenyl</b>												
2,4'-DDT	Liver lesions						✓					
4,4'-DDT	Liver lesions						✓					
Aldrin	Hepatotoxicity						✓					
alpha-Chlordane	Liver hypertrophy						✓					
Dieldrin	Liver lesions						✓					
Endrin	Liver lesions, CNS convulsions			✓			✓					
Endrin ketone	Liver lesions, CNS convulsions			✓			✓					
gamma-BHC (Lindane)	Liver and kidney toxicity				✓		✓					
gamma-Chlordane	Liver hypertrophy						✓					
Heptachlor	Increased liver weight						✓					
Heptachlor epoxide	Increased liver weight						✓					

TABLE 7-3 (Continued)

**NONCARCINOGENIC CRITICAL EFFECTS FOR CHEMICALS OF POTENTIAL CONCERN  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Chemical of Potential Concern <sup>a</sup>	Critical Effect or Site of Critical Effect <sup>b</sup>	CV	Blood	CNS/PNS	Kidney	GI	Liver	Resp	Skin	Body Wt	Repro	Other
<b>Pesticide/Polychlorinated Biphenyl (Continued)</b>												
Hexachlorobenzene	Liver effects						✓					
Mirex	Liver and thyroid effects						✓					✓
Technical chlordane	Liver hypertrophy						✓					
Trans-nonachlor	Liver hypertrophy						✓					
<b>Explosive</b>												
1,3-Dinitrobenzene	Increased splenic weight											✓
HMX	Hepatic lesions						✓					✓

**Notes**

Body Wt    Altered body weight

CNS/PNS    Central nervous system/peripheral nervous system

CV    Cardiovascular system

DDT    Dichlorodiphenyltrichloroethane

GI    Gastrointestinal system

a    Includes all chemicals of potential concern at the Tidal Area sites for which noncancer PRGs are available

b    Critical effect following oral exposure unless otherwise noted

c    Critical effect following inhalation exposure

-    Not available

HMX

Cyclotetramethylene tetranitramine

Other

All other toxicological endpoints

Repro

Reproductive effects including teratogenic and developmental effects

Resp

Respiratory system

Skin

Skin irritation or other effect



TABLE 7-4

**SITE 1 - TIDAL AREA LANDFILL  
SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, INDUSTRIAL SCENARIO  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Surface soil	Cancer Risk	Arsenic (8/8)	33.8	1.1E-05	No source of arsenic was identified. The risk associated with industrial exposure to ambient levels of arsenic is 9.0E-06.
	Hazard Index	--	--	--	
	Lead Evaluation	--	--	--	The RME lead concentration in surface soil (108 mg/kg) was less than the industrial PRG of 1,000 mg/kg.
Subsurface soil	Cancer Risk	Arsenic (24/24)	19.2	6.4E-06	The risk associated with industrial exposure to ambient levels of arsenic is 9.0E-06.
	Hazard Index	--	--	--	
	Lead Evaluation	--	--	--	The RME concentration in subsurface soil (56.7 mg/kg) was less than the industrial PRG of 1,000 mg/kg.

## Notes:

ASTDR Agency for Toxic Substances and Disease Register

HQ Hazard quotient

mg/kg Milligrams per kilogram

mg/L Milligrams per liter

NWS Naval Weapons Station

PRG Preliminary remediation goal

RME Reasonable maximum exposure

<sup>a</sup> The chemicals listed are those for which the carcinogenic risk exceeds 1E-06 or the segregated hazard index exceeds 1.<sup>b</sup> The units are in mg/kg.

-- Not applicable or not available





TABLE 7-5

**SITE 1 - TIDAL AREA LANDFILL  
SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, RESIDENTIAL SCENARIO  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Surface soil	Cancer Risk	Arsenic (8/8)	33.8	8.9E-05	No source of arsenic was identified. The risk associated with residential exposure to ambient levels of arsenic is 7.1E-05.
		Benzo(a)pyrene (1/7)	0.07	1.3E-06	The risk for benzo(a)pyrene is based on a single detection (0.07 mg/kg) that is comparable to background levels in urban and rural soils (ATSDR 1995).
	Hazard Index	Arsenic (8/8)	33.8	1.61	The total hazard index for the RME case is 2.1. The maximum segregated hazard index is for the cardiovascular system and skin and is attributable to arsenic.
	Lead Evaluation	--	--	--	
Subsurface soil	Cancer Risk	Arsenic (24/24)	19.2	5.1E-05	The risk associated with residential exposure to ambient levels of arsenic is 7.1E-05.
		Benzo(a)pyrene (1/7)	0.07	1.3E-06	The risk for benzo(a)pyrene is based on a single detection (0.07 mg/kg) that is comparable to background levels in urban and rural soils (ATSDR 1995).
	Hazard Index	--	--	--	
	Lead Evaluation	--	--	--	

## Notes:

- ASTDR Agency for Toxic Substances and Disease Register
- HQ Hazard quotient
- mg/kg Milligrams per kilogram
- <sup>a</sup> The chemicals listed are those for which the carcinogenic risk exceeds 1E-06 or the segregated hazard index exceeds 1.
- <sup>b</sup> The units are in mg/kg.
- Not applicable or not available
- RME Reasonable maximum exposure
- Milligrams per liter
- Naval Weapons Station
- Preliminary remediation goal



TABLE 7-6

**SITE 2 - R AREA DISPOSAL  
SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, INDUSTRIAL SCENARIO  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Surface soil	Cancer Risk	Arsenic (110/111)	13.6	4.5E-06	No source of arsenic was identified. The risk associated with industrial exposure to ambient levels of arsenic is 9.0E-06.
	Hazard Index	--	--	--	
	Lead Evaluation	--	--	--	The RME lead concentration in surface soil (77.7 mg/kg) was less than the industrial PRG of 1,000 mg/kg.
Subsurface soil	Cancer Risk	Arsenic (126/131)	13.9	4.6E-06	The risk associated with industrial exposure to ambient levels of arsenic is 9.0E-06.
	Hazard Index	--	--	--	
	Lead Evaluation	--	--	--	The RME lead concentration in subsurface soil (77.7 mg/kg) was less than the industrial PRG of 1,000 mg/kg.
Surface Water	Cancer Risk	--	--	--	
	Hazard Index	--	--	--	

## Notes:

HQ Hazard quotient  
mg/kg Milligrams per kilogram  
mg/L Milligrams per liter

NWS Naval Weapons Station  
PRG Preliminary remediation goal  
RME Reasonable maximum exposure

<sup>a</sup> The chemicals listed are those for which the carcinogenic risk exceeds 1E-06 or the segregated hazard index exceeds 1.

<sup>b</sup> The units are in mg/kg, except for surface water concentrations which are in mg/L.

-- Not applicable or not available



TABLE 7-7

SITE 2 - R AREA DISPOSAL  
 SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, RESIDENTIAL SCENARIO  
 TIDAL AREA REMEDIAL INVESTIGATION  
 NWS SBD CONCORD, CALIFORNIA

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Surface soil	Cancer Risk	Arsenic (110/111)	13.6	3.6E-05	No source of arsenic was identified. The risk associated with residential exposure to ambient levels of arsenic is 7.1E-05.
		Benzo(a)pyrene (14/65)	0.1	1.8E-06	The risk for benzo(a)pyrene is based on an RME concentration that is comparable to background levels in urban and rural soils (ATSDR 1995).
		Dibenz(a,h)anthracene (5/65)	0.09	1.6E-06	The risk for dibenz(a,h)anthracene is based on an RME and maximum concentration (0.09 mg/kg) that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).
Subsurface soil	Hazard Index Lead Evaluation	--	--	--	The RME lead concentration in surface soil (108 mg/kg) was less than the residential PRG of 130 mg/kg.
		Arsenic (126/131)	13.9	3.7E-05	The risk associated with residential exposure to ambient levels of arsenic is 7.1E-05.
		Benzo(a)pyrene (15/85)	0.2	3.6E-06	The risk for benzo(a)pyrene is based on an RME concentration that is comparable to background levels in urban and rural soils (ATSDR 1995).
Surface Water		Dibenz(a,h)anthracene (5/85)	0.09	1.6E-06	The risk for dibenz(a,h)anthracene is based on an RME and maximum concentration (0.09 mg/kg) that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).
	Hazard Index	--	--	--	
	Lead Evaluation	--	--	--	
Surface Water	Cancer Risk	--	--	--	
	Hazard Index	--	--	--	

TABLE 7-7 (continued)

**SITE 2 - R AREA DISPOSAL  
SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, RESIDENTIAL SCENARIO  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Notes:	
ASTDR	Agency for Toxic Substances and Disease Register
HQ	Hazard quotient
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
NWS	Naval Weapons Station
PRG	Preliminary remediation goal
RME	Reasonable maximum exposure
a	The chemicals listed are those for which the carcinogenic risk exceeds 1E-06 or the segregated hazard index exceeds 1.
b	The units are in mg/kg.
--	Not applicable or not available

TABLE 7-8

**SITE 9 - FROID & TAYLOR ROADS  
SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, INDUSTRIAL SCENARIO  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Surface soil	Cancer Risk	--	--	--	
	Hazard Index	--	--	--	
	Lead Evaluation	--	--	--	The RME lead concentration in surface soil (515 mg/kg) was less than the industrial PRG of 1,000 mg/kg.
Subsurface soil	Cancer Risk	--	--	--	
	Hazard Index	--	--	--	
	Lead Evaluation	--	--	--	The RME lead concentration in subsurface soil (319 mg/kg) was less than the industrial PRG of 1,000 mg/kg.
Surface water	Cancer Risk	Arsenic (9/9)	0.28	3.5E-06	The risk for arsenic is based on the maximum detected concentration in surface water (0.28 mg/L).
	Hazard Index	--	--	--	

## Notes:

ASTDR Agency for Toxic Substances and Disease Register

HQ Hazard quotient

mg/kg Milligrams per kilogram

mg/L Milligrams per liter

<sup>a</sup><sup>b</sup> The chemicals listed are those for which the carcinogenic risk exceeds 1E-06 or the segregated hazard index exceeds 1.

The units are in mg/kg.

-- Not applicable or not available

NWS Naval Weapons Station  
PRG Preliminary remediation goal  
RME Reasonable maximum exposure





TABLE 7-9

**SITE 9 - FROID & TAYLOR ROADS  
SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, RESIDENTIAL SCENARIO  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Surface soil	Cancer Risk	Benzo(a)pyrene (2/11)	0.1	1.8E-06	The risk for benzo(a)pyrene is based on an RME and maximum concentration that is comparable to background levels in urban and rural soils (ATSDR 1995).
	Hazard Index	--	--	--	The RME lead concentration is equal to the maximum concentration and is greater than the residential PRG of 130 mg/kg. The mean lead concentration is 160 mg/kg.
	Lead Evaluation	Lead (11/11)	515	--	
Subsurface soil	Cancer Risk	Benzo(a)pyrene (2/17)	0.1	1.8E-06	The risk for benzo(a)pyrene is based on an RME and maximum concentration that is comparable to background levels in urban and rural soils (ATSDR 1995).
	Hazard Index	--	--	--	The RME lead concentration is greater than the residential PRG of 130 mg/kg. The mean lead concentration is 94.3 mg/kg.
	Lead Evaluation	Lead (18/18)	319	--	
Surface Water	Cancer Risk	Arsenic (9/9)	0.28	5.3E-06	The risk for arsenic is based on the maximum detected concentration in surface water (0.28 mg/L).
	Hazard Index	--	--	--	

## Notes:

ASTDR  
HQ  
mg/kg

Agency for Toxic Substances and Disease Register

Hazard quotient

Milligrams per kilogram

a

The chemicals listed are those for which the carcinogenic risk exceeds 1E-06 or the segregated hazard index exceeds 1.

b

The units are in mg/kg.

Not applicable or not available

RME Reasonable maximum exposure

mg/L  
NWS

Naval Weapons Station

PRG Preliminary remediation goal



TABLE 7-10

**SITE 11 - WOOD HOGGER**  
**SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, INDUSTRIAL SCENARIO**  
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD CONCORD, CALIFORNIA**

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Surface soil	Cancer Risk	Arsenic (70/75)	12.1	4.0E-06	The RME concentration for arsenic is below the ambient level for arsenic (27 mg/kg). The risk associated with industrial exposure to ambient levels of arsenic is 9.0E-06.
		Benzo(a)pyrene (14/56)	1.0	2.8E-06	The risk for benzo(a)pyrene is based on an RME concentration that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).
		Dibenz(a,h)anthracene (4/56)	0.6	1.7E-06	The risk for dibenz(a,h)anthracene is based on an RME and maximum concentration (0.6 mg/kg) that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).
		Dioxins/Furans (7/9)	0.000343	1.1E-05	The risk for dioxins/furans is based on the maximum detected TCDD TEQ concentration (0.000343 mg/kg). A total of four dioxin and furan congeners were detected at the site.
	Hazard Index	--	--	--	
Subsurface soil	Lead Evaluation	Lead (75/75)	101	--	The RME lead concentration in surface soil (101 mg/kg) is less than the industrial PRG of 1,000 mg/kg.
	Cancer Risk	Arsenic (113/123)	10.7	3.6E-06	The RME concentration for arsenic is below the ambient level for arsenic (27 mg/kg). The risk associated with industrial exposure to ambient levels of arsenic is 9.0E-06.
		Benzo(a)pyrene (14/105)	0.7	1.9E-06	The risk for benzo(a)pyrene is based on an RME concentration that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).

TABLE 7-10 (Continued)

**SITE 11 - WOOD HOGGER**  
**SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, INDUSTRIAL SCENARIO**  
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD CONCORD, CALIFORNIA**

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Subsurface soil (Continued)	Cancer Risk (Continued)	Dibenz(a,h)anthracene (4/105)	0.6	1.7E-06	The risk for dibenz(a,h)anthracene is based on an RME and maximum concentration (0.6 mg/kg) that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).
		Dioxins/Furans (9/11)	0.000343	1.1E-05	The risk for dioxins/furans is based on the maximum detected TCDD TEQ concentration (0.000343 mg/kg). A total of four dioxin and furan congeners were detected at the site.
	Hazard Index	--	--	--	
	Lead Evaluation	Lead (122/123)	63.9	--	The RME lead concentration is less than the industrial PRG of 1,000 mg/kg.
Surface Water	Cancer Risk	--	--	--	No carcinogenic COCs identified in surface water at Site 11.
	Hazard Index	--	--	--	

## Notes:

ASTDR Agency for Toxic Substances and Disease Register  
 HQ Hazard quotient  
 mg/kg Milligrams per kilogram  
 mg/L Milligrams per liter

<sup>a</sup> The chemicals listed are those for which the carcinogenic risk exceeds 1E-06 or the segregated hazard index exceeds 1.

<sup>b</sup> The units are in mg/kg.

-- Not applicable or not available

NWS Naval Weapons Station

PRG Preliminary remediation goal

RME Reasonable maximum exposure

TABLE 7-11

**SITE 11 - WOOD HOGGER**  
**SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, RESIDENTIAL SCENARIO**  
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD CONCORD, CALIFORNIA**

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Surface soil	Cancer Risk 1.6E-04	Arsenic (70/75)	12.1	3.2E-05	The RME concentration for arsenic is below the ambient level for arsenic (27 mg/kg). The risk associated with residential exposure to ambient levels of arsenic is 7.1E-05.
		Benzo(a)anthracene (12/56)	1.0	1.8E-06	The risk for benzo(a)anthracene is based on an RME concentration that is comparable to background levels in urban and rural soils (ATSDR 1995).
		Benzo(a)pyrene (14/56)	1.0	1.8E-05	The risk for benzo(a)pyrene is based on an RME concentration that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).
		Benzo(b)fluoranthene (15/56)	1.0	1.8E-06	The risk for benzo(b)fluoranthene is based on an RME concentration that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).
		Benzo(k)fluoranthene (13/56)	1.0	1.6E-06	The risk for benzo(k)fluoranthene is based on an RME concentration that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).
		Dibenz(a,h)anthracene (4/56)	0.6	1.1E-05	The risk for dibenz(a,h)anthracene is based on an RME and maximum concentration that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).
		Indeno(1,2,3-cd)pyrene (9/56)	1.0	1.8E-06	The risk for indeno(1,2,3-cd)pyrene is based on an RME and maximum concentration (1.0 mg/kg) that is comparable to background levels in urban and rural soils (ATSDR 1995).
		Dioxins/Furans (7/9)	0.000343	9.0E-05	The risk for dioxins/furans is based on the maximum detected TCDD TEQ concentration (0.000343 mg/kg). A total of four dioxin and furan congeners were detected at the site.

TABLE 7-11 (Continued)

**SITE 11 - WOOD HOGGER**  
**SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, RESIDENTIAL SCENARIO**  
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD CONCORD, CALIFORNIA**

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Surface soil (Continued)	Hazard Index 0.67	--	--	--	The total hazard index for the RME case is 1.33. The maximum segregated hazard index is for skin and is attributable to arsenic.
	Lead Evaluation --	Lead (75/75)	101	--	The RME lead concentration in surface soil (101 mg/kg) is less than the residential PRG of 130 mg/kg.
Subsurface soil	Cancer Risk 1.5E-04	Arsenic (113/123)	10.7	2.8E-05	The RME concentration for arsenic is below the ambient level for arsenic (27 mg/kg). The risk associated with residential exposure to ambient levels of arsenic is 7.1E-05.
		Benzo(a)anthracene (12/105)	0.7	1.3E-06	The risk for benzo(a)anthracene is based on an RME concentration that is comparable to background levels in urban and rural soils (ATSDR 1995).
		Benzo(a)pyrene (14/105)	0.7	1.3E-05	The risk for benzo(a)pyrene is based on an RME concentration that is comparable to background levels in urban and rural soils (ATSDR 1995).
		Benzo(b)fluoranthene (16/105)	0.7	1.3E-06	The risk for benzo(b)fluoranthene is based on an RME concentration that is comparable to background levels in urban and rural soils (ATSDR 1995).
		Benzo(k)fluoranthene (13/105)	0.7	1.1E-06	The risk for benzo(k)fluoranthene is based on an RME concentration that is comparable to background levels in urban and rural soils (ATSDR 1995).
		Dibenz(a,h)anthracene (4/105)	0.6	1.1E-05	The risk for dibenz(a,h)anthracene is based on an RME and maximum concentration (0.6 mg/kg) that is comparable to background PAH levels in urban and rural soils (ATSDR 1995).

TABLE 7-11 (Continued)

**SITE 11 - WOOD HOGGER**  
**SUMMARY OF HUMAN HEALTH RISKS AND HAZARDS, RESIDENTIAL SCENARIO**  
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD CONCORD, CALIFORNIA**

Media	RME Multichemical Risk Assessment Results	Risk Drivers <sup>a</sup>			Comments
		Chemical (Detection Frequency)	RME Concentration <sup>b</sup>	Risk/HQ	
Subsurface soil (Continued)	Cancer Risk (Continued)	Indeno(1,2,3-cd)pyrene (9/105)	0.7	1.3E-06	The risk for indeno(1,2,3-cd)pyrene is based on an RME concentration that is comparable to background levels found in urban and rural soils (ATSDR 1995).
		Dioxins/Furans (9/11)	0.000343	9.0E-05	The risk for dioxins/furans is based on the maximum detected TCDD TEQ concentration (0.000343 mg/kg). A total of four dioxin and furan concentrations were detected at the site.
	Hazard Index	--	--	--	The total hazard index for the RME case is 1.22. The maximum segregated hazard index is for skin and is attributable to arsenic.
	Lead Evaluation	Lead (122/123)	63.9	--	The RME lead concentration in subsurface soils (63.9 mg/kg) is less than the residential PRG of 130 mg/kg.
Surface Water	Cancer Risk			--	No carcinogenic COCs identified in surface water at Site 11.
	Hazard Index			--	No noncarcinogenic COCs identified in surface water at Site 11.

## Notes:

ASTDR Agency for Toxic Substances and Disease Register

HQ Hazard quotient

mg/kg Milligrams per kilogram

mg/L Milligrams per liter

NWS Naval Weapons Station

PAH Polynuclear aromatic hydrocarbon

PRG Preliminary remediation goal

RME Reasonable maximum exposure

TCDD Tetrachloro-dibenzo-p-dioxin

TEQ Toxicity equivalents

The chemicals listed are those for which the carcinogenic risk exceeds 1E-06 or the segregated hazard index exceeds 1.

The units are in mg/kg.

Not applicable or not available





TABLE 7-12

**SUMMARY OF CANCER RISK AND HAZARD INDEX  
FOR INDUSTRIAL EXPOSURE TO AMBIENT LEVELS OF METALS  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Metal	99th Percentile Concentration (mg/kg)	1998 Industrial PRG		Cancer Risk	Hazard Quotient
		Cancer	Noncancer		
Aluminum	27,300	--	1,900,000	--	0.01
Antimony	2.2	--	750	--	< 0.01
Arsenic	27	3	480	9.0E-06	0.06
Barium	530	--	120,000	--	< 0.01
Beryllium	0.18	--	3,400	--	< 0.01
Cadmium	1.9	3,000	930	6.3E-10	< 0.01
Chromium	82.1	450	--	1.8E-07	--
Cobalt	36	--	29,000	--	< 0.01
Copper	81	--	70,000	--	< 0.01
Iron	90,000	--	560,000	--	0.16
Lead	95	--	1,000	--	0.10
Manganese	1,500	--	45,000	--	0.03
Mercury	0.32	--	560	--	< 0.01
Molybdenum	6.6	--	9,400	--	< 0.01
Nickel	120	--	37,000	--	< 0.01
Selenium	2.8	--	9,400	--	< 0.01
Silver	0	--	9,400	--	< 0.01
Thallium	2.2	--	130	--	0.02
Vanadium	96	--	13,000	--	< 0.01
Zinc	264	--	560,000	--	< 0.01
<b>TOTAL:</b>				<b>9.2E-06</b>	<b>0.38</b>

Notes:

mg/kg Milligram per kilogram

PRG Preliminary remediation goal



TABLE 8-1

**PHYSICAL-CHEMICAL PROPERTIES OF SITE-RELATED ORGANIC CHEMICALS  
THAT POTENTIALLY EXCEEDED A RISK OF  $1 \times 10^{-6}$   
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

CAS <sup>a</sup> Number	Analyte	COC <sup>b</sup> Medium	Analyte Class <sup>c</sup>	Chlorinated (Y/N) <sup>d</sup>	Solubility (mg/L at 25°C)	Vapor Pressure (mm Hg at 20°C)	Henry's Law Constant (atm-m <sup>3</sup> /mol at 20°C)	Log K <sub>ow</sub> <sup>e</sup>	K <sub>oc</sub>	Log K <sub>ow</sub> <sup>f</sup>	Molecular Weight	Density (g/cm <sup>3</sup> at 20°C)
50-32-8	Benzo(a)pyrene <sup>1</sup>	Soil	S	N	4.00E-03	5.60E-09	2.40E-06	6.50	1.95E+06	6.29	252	1.35
53-70-3	Dibenz(a,h)anthracene <sup>1</sup>	Soil	S	N	2.49E-03	1.00E-10	7.33E-09	6.50	1.66E+06	6.22	278	1.28
35822-46-9	1,2,3,4,6,7,8-HPeCDD <sup>2</sup>	Soil	D	Y	2.0E-08	--	--	--	--	--	--	--
1746-01-6	2,3,7,8-TCDD <sup>2</sup>	Soil	D	Y	3.17E-10	1.0E-05 to 1.7E-06	5.4	6.15 to 6.84	9.9E+05 to 3.3E+06	6.00 to 6.52	321.96	1.827 (25°C)

## Notes:

atm-m<sup>3</sup>/mol      Atmospheres-cubic meters per mole  
g/cm<sup>3</sup>              Grams per cubic centimeter  
HPeCDD          Hepachlorodibenzo-p-dioxin  
K<sub>oc</sub>                Organic carbon partition coefficient

a                    Chemical Abstracts Service

b                    Chemical of concern

c                    Analytes are classified as semivolatile organic compounds (S), pesticide (P), polychlorinated biphenyls (B), or dioxin (D).

d                    For organic compounds, N indicates that the compound is not chlorinated; Y indicates that the compound is chlorinated.

e                    Octanol/water partition coefficient

f                    Organic carbon partition coefficient

g                    2,3,7,8-Tetrachlorodibenzo-p-dioxin was not detected above laboratory method detection limits. It is included because equivalent concentrations of this dioxin are calculated from the detected dioxin concentrations.

--                  Information not available

## References:

- 1                    Information gathered from Montgomery and Welton (1991); Merck Index, 11th Edition; National Institute of Occupational Safety and Health (1994); Howard and others (1991); EPA (1988)
- 2                    Hazardous Substances Databank



TABLE 8-2

**PERSISTENCY OF ORGANIC CHEMICALS THAT EXCEED A RISK OF  $1 \times 10^{-6}$**   
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD CONCORD, CALIFORNIA**

CAS Number	Analyte	Half-Life (days)		
		Soil	Surface Water	Groundwater
50-32-8	Benzo(a)pyrene <sup>a</sup>	57-530	0.02-0.05	114-1,060
53-70-3	Dibenz(a,h)anthracene <sup>a</sup>	361-940	0.25-32.6	722-1,880
35822-46-9	1,2,3,4,6,7,8-HPCDD	--	--	--
1746-01-6	2,3,7,8-TCDD <sup>b,c</sup>	1-12 years	46 days to > 50 years	--

## Notes:

CAS      Chemical Abstracts Service  
HPCDD    Heptachlorodibenzo-p-dioxin  
TCDD     Tetrachlorodibenzo-p-dioxin

a        Howard and others (1990)

b        Hazardous Substances Databank

c        2,3,7,8-TCDD was not detected above laboratory method detection limits. It is included because equivalent concentrations of this dioxin are calculated from the detected concentrations.

--       Information not available



TABLE 8-3

**MOBILITY AND PERSISTENCE FACTOR CLASSES  
TIDAL AREA REMEDIAL INVESTIGATION  
NWS SBD CONCORD, CALIFORNIA**

Mobility and Persistence Class	Mobility Factors					Persistence Factors	
	Water Solubility (mg/L)	Log $K_{ow}$	Log $K_{oc}$	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m <sup>3</sup> /mol)	Surface Water Half-Life (days)	Groundwater Half-Life (days)
Low	< 10	> 3	> 2.7	< 1.0E-7	< 3.0E-7	< 0.5	< 30
Medium	10 to 1,000	2.7 to 3.0	1.7 to 2.7	1.0E-7 to 0.01	3.0E-7 to 0.001	0.5 - 1.0	30 to 90
High	> 1,000	< 2.7	< 1.7	> 0.01	> 0.001	> 1.0	> 90

## Notes:

atm-m<sup>3</sup>/mol    Atmospheres-cubic meters per mole  
 $K_{oc}$             Organic carbon partition coefficient  
 $K_{ow}$             Octanol/water partition coefficient  
 mg/L            Milligrams per liter  
 mm Hg          Millimeters of mercury





TABLE 8-4

**MOBILITY AND PERSISTENCE FACTOR CLASSES FOR ORGANIC CHEMICALS THAT EXCEED A RISK OF  $1 \times 10^{-6}$**   
**TIDAL AREA REMEDIAL INVESTIGATION**  
**NWS SBD CONCORD, TIDAL AREA SITES**

Analyte	Mobility Factor Classes				Persistence Factor Classes		
	Water Solubility Class	Log $K_{ow}$ Class	Log $K_{oc}$ Class	Vapor Pressure Class	Henry's Law Constant Class	Surface Water Half-Life Class	Groundwater Half-Life Class
Benzo(a)pyrene	Low	Low	Low	Low	Medium	Low	High
Dibenz(a,h)anthracene	Low	Low	Low	Low	Low	Low to high	High
1,2,3,4,6,7,8-HPCDD	Low	--	--	--	--	--	--
2,3,7,8-TCDD*	Low	Low	Low	Medium	High	High	--

## Notes:

HPCDD    Heptachlorodibenzo-p-dioxin

$K_{oc}$     Organic carbon partition coefficient

$K_{ow}$     Octanol/water partition coefficient

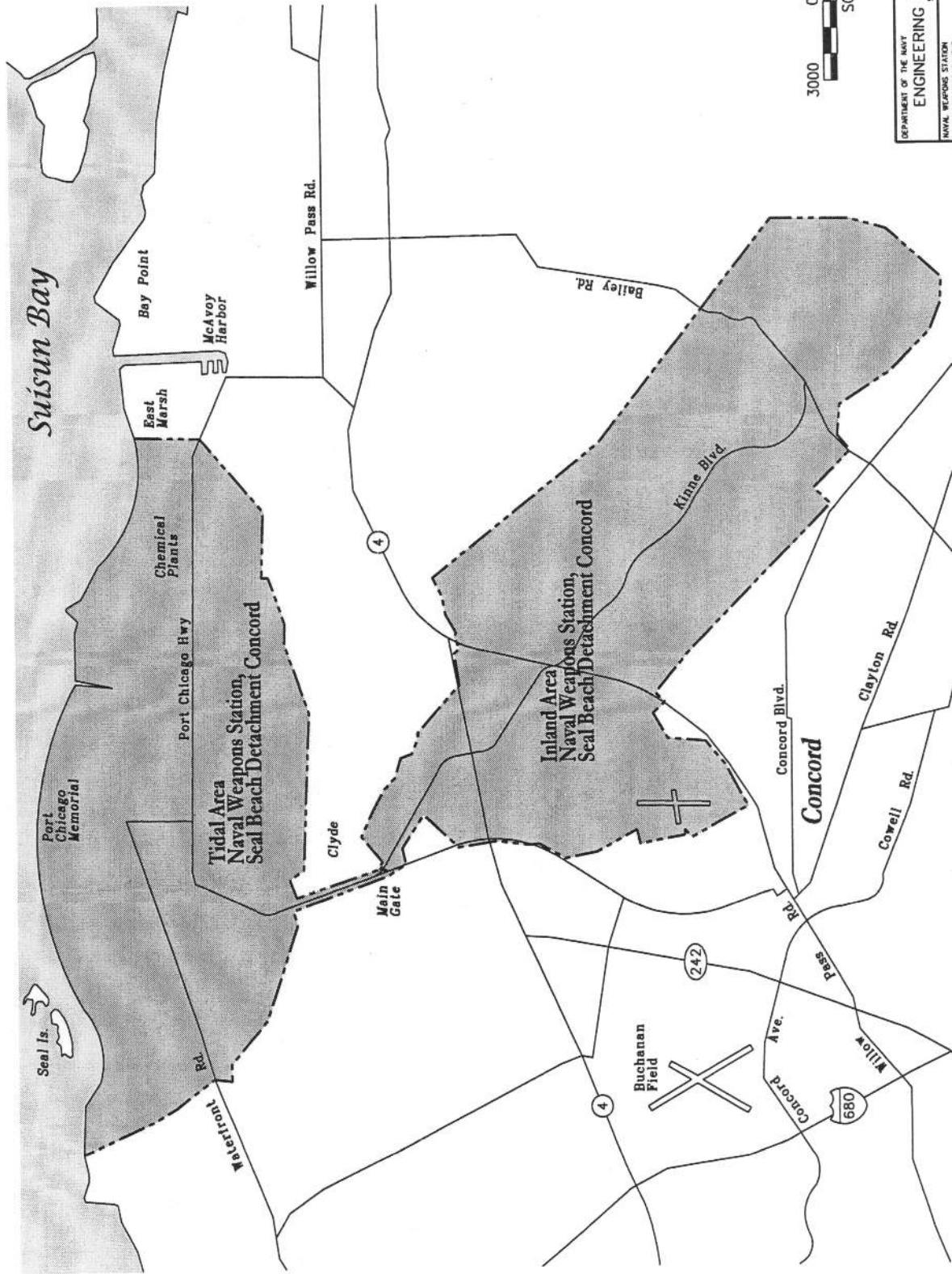
TCDD    Tetrachlorodibenzo-p-dioxin

a    2,3,7,8-TCDD was not detected above laboratory method detection limits. However, 2,3,7,8-TCDD is included because equivalent concentrations of this dioxin were calculated from the concentrations of other detected dioxin compounds.

--    Information not available

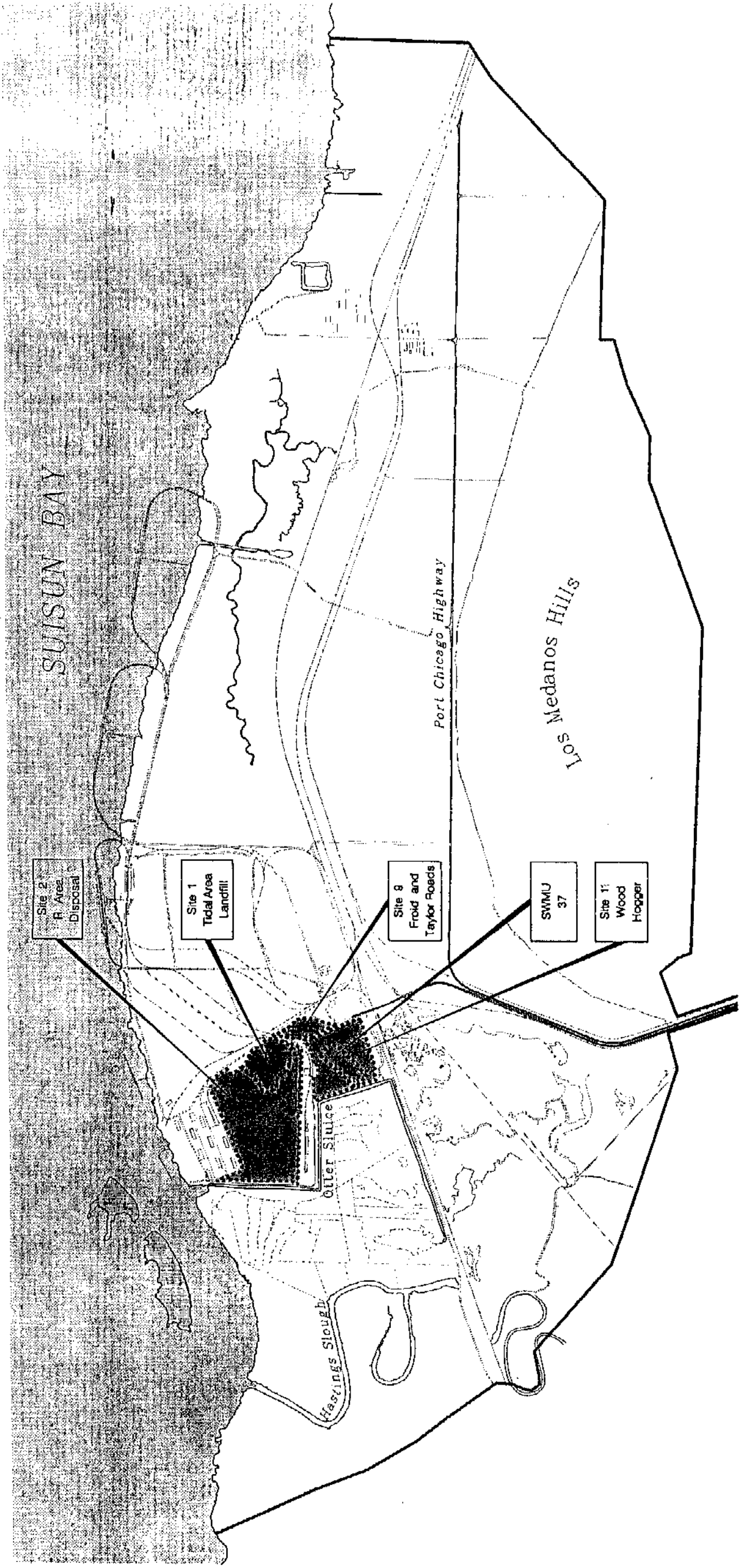


## FIGURES



DEPARTMENT OF THE NAVY  
ENGINEERING FIELD ACTIVITY WEST  
NAVY FACILITIES ENGINEERING COMMAND  
SAN BRUNO, CALIFORNIA  
CONCORD, CALIFORNIA  
NAVY WEAPONS STATION  
SEAL BEACH DETACHMENT

FIGURE 1-1  
VICINITY OF  
NWS SBD CONCORD



LEGEND

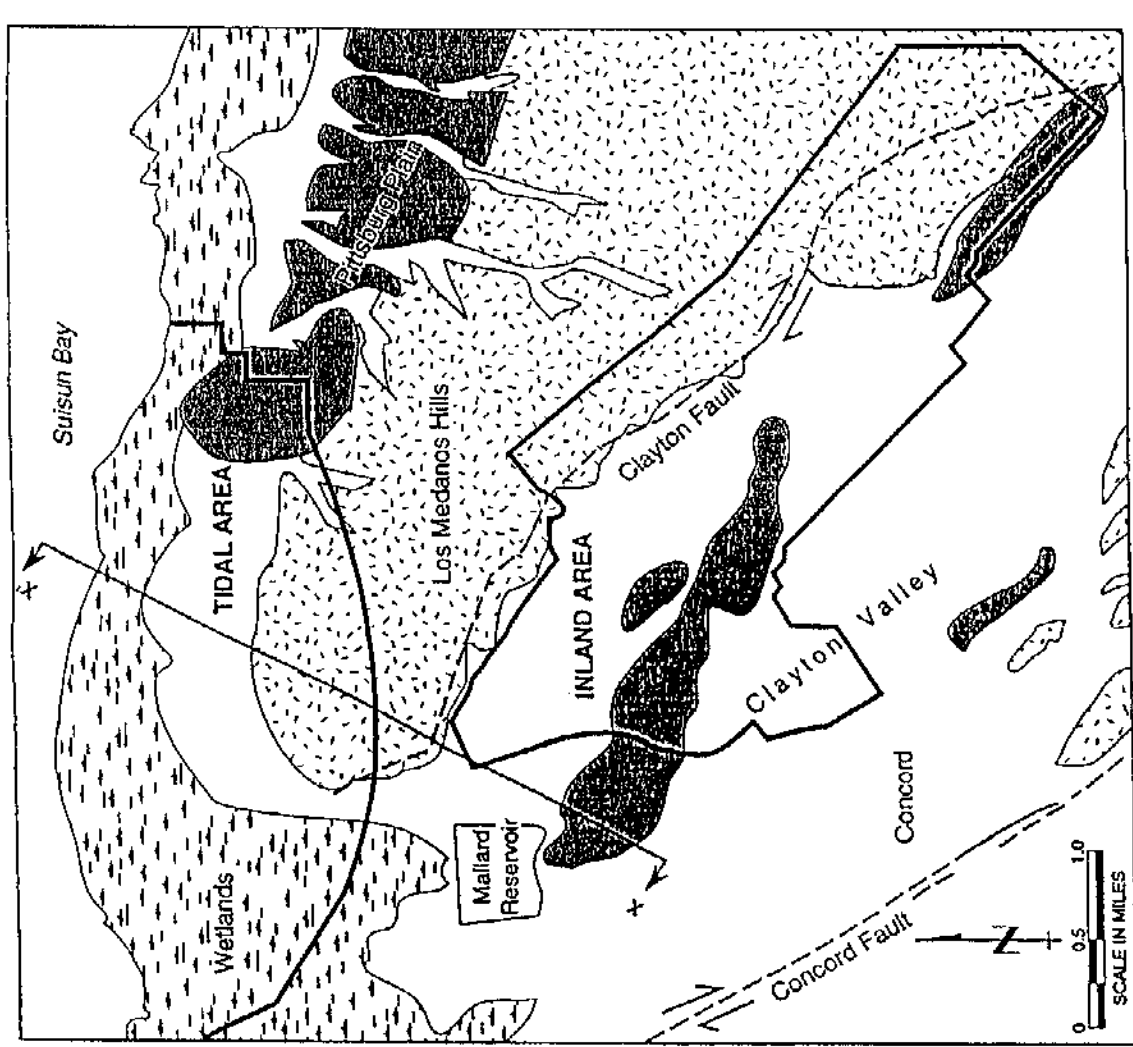
- NWS Tidal Area Boundary
- ..... Site Boundary
- - - - Railroad Tracks
- Road
- Building

DEPARTMENT OF THE NAVY  
NAVAL FACILITIES ENGINEERING COMMAND  
ENGINEERING FIELD ACTIVITY WEST  
SAN BRUNO, CALIFORNIA  
NAVAL WEAPONS STATION  
SEAL BEACH DETACHMENT  
CONCORD, CALIFORNIA

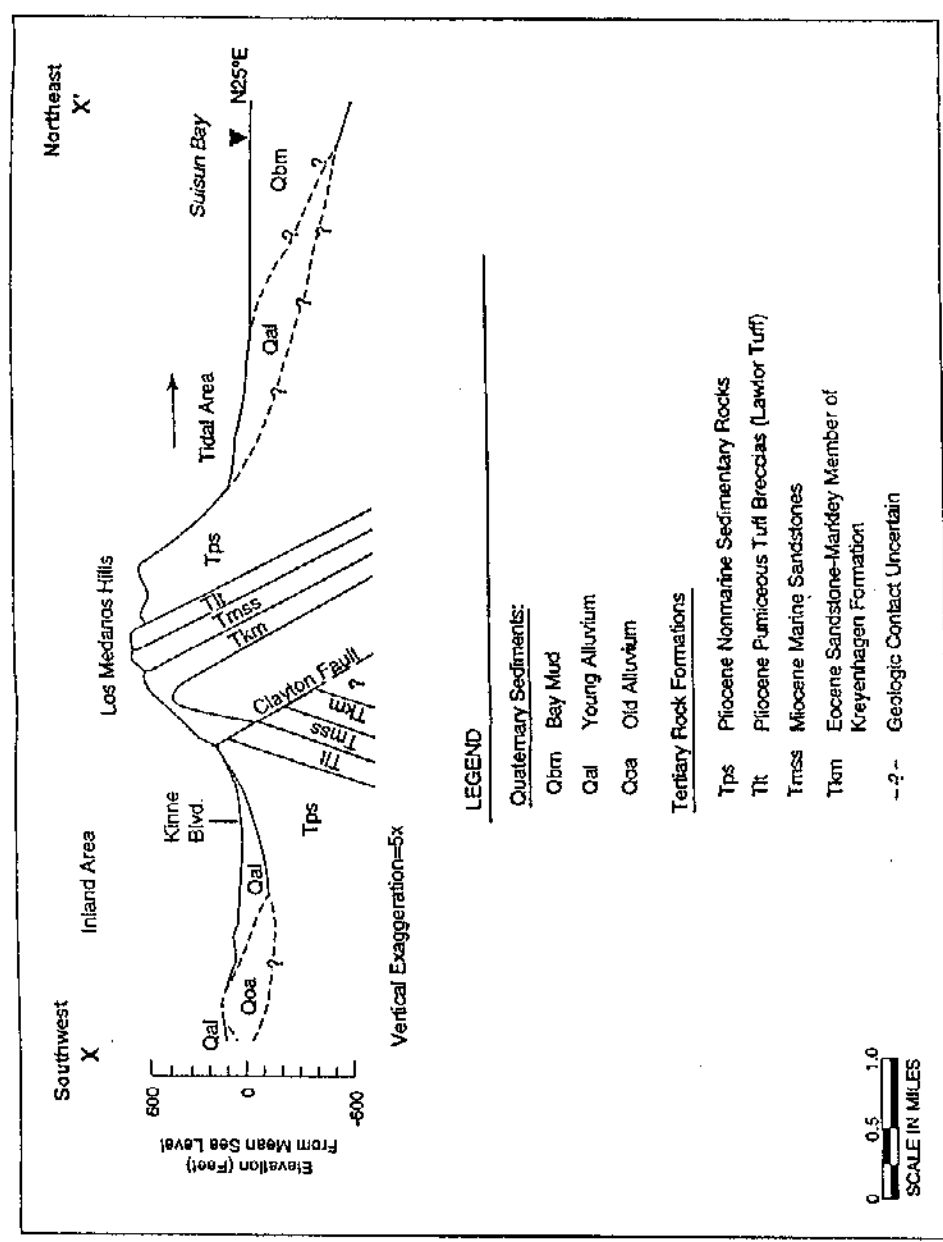
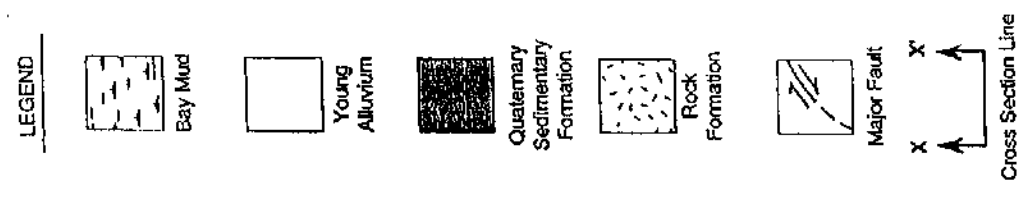
FIGURE 1-2  
NWS CONCORD  
TIDAL AREA

## Figures 1-3 to 2-7

These detailed station maps have been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.



Source: LUTTON, et al., 1987  
DIBBLEE, 1980a,b,c, 1981



Source: Adapted from DIBBLEE, 1981

NWS CONCORD - TIDAL AREA  
CONCORD, CALIFORNIA

FIGURE 2-6  
GEOLOGY OF NWS CONCORD

Date: 4/96

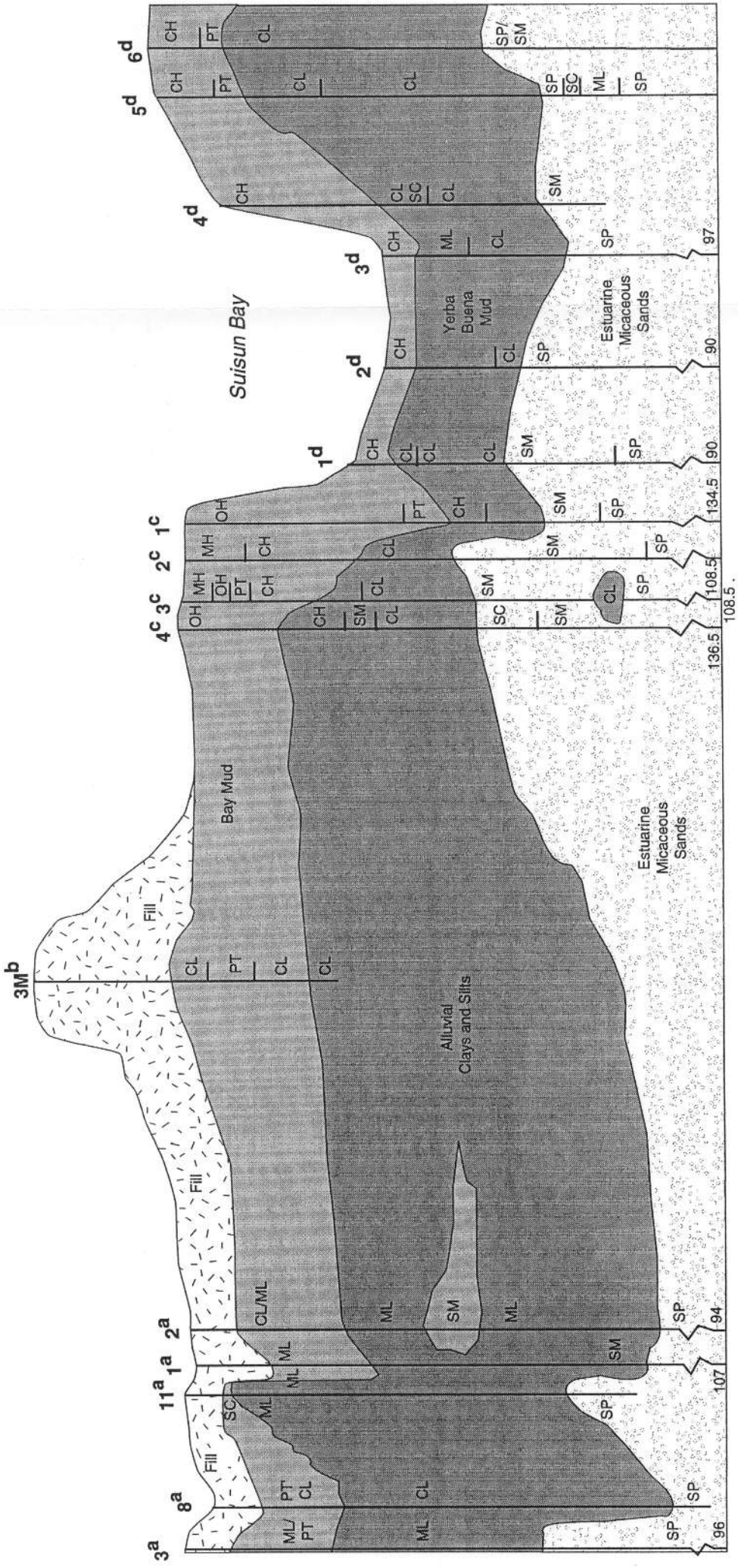
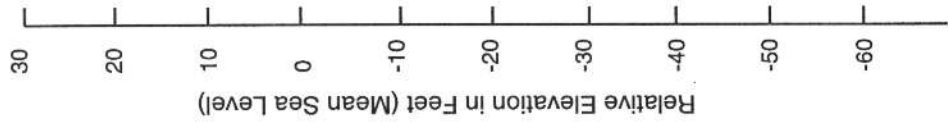
029702



Figure 2-9

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

WEST  
A



EAST  
A'

UNIFIED SOIL CLASSIFICATION SYSTEM	
Group Symbol	Typical Name
SP	Poorly-graded sands, gravelly sands, little or no fines
SM	Silty sands, poorly-graded sand-gravel-silt mixtures
SC	Clayey sands, poorly-graded sand-gravel-clay mixtures
ML	Inorganic silts & very fine sands, silty or clayey fine sands, silts with slight plasticity
CL	Organic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
MH	Inorganic silts, micaceous or diatomaceous fine sand or silt
CH	Inorganic clays of high plasticity, fat clays
OH	Organic silts & clays of medium-to-high-plasticity
PT	Peat, humus, swamp soils with high organic content

LEGEND

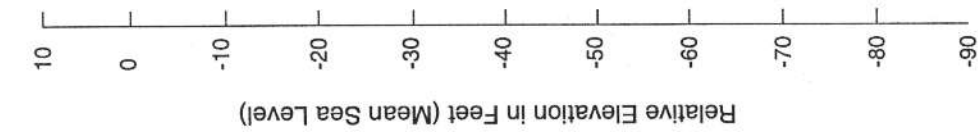


Resources for Soil Boring Information:

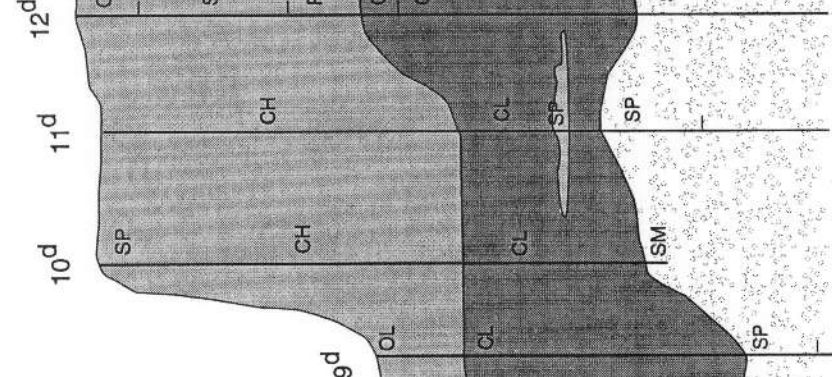
- a - Lee and Prasker, 1967
- b - Dames and Moore, 1943
- c - Woodward Clyde, 1978
- d - Dames and Moore, 1966



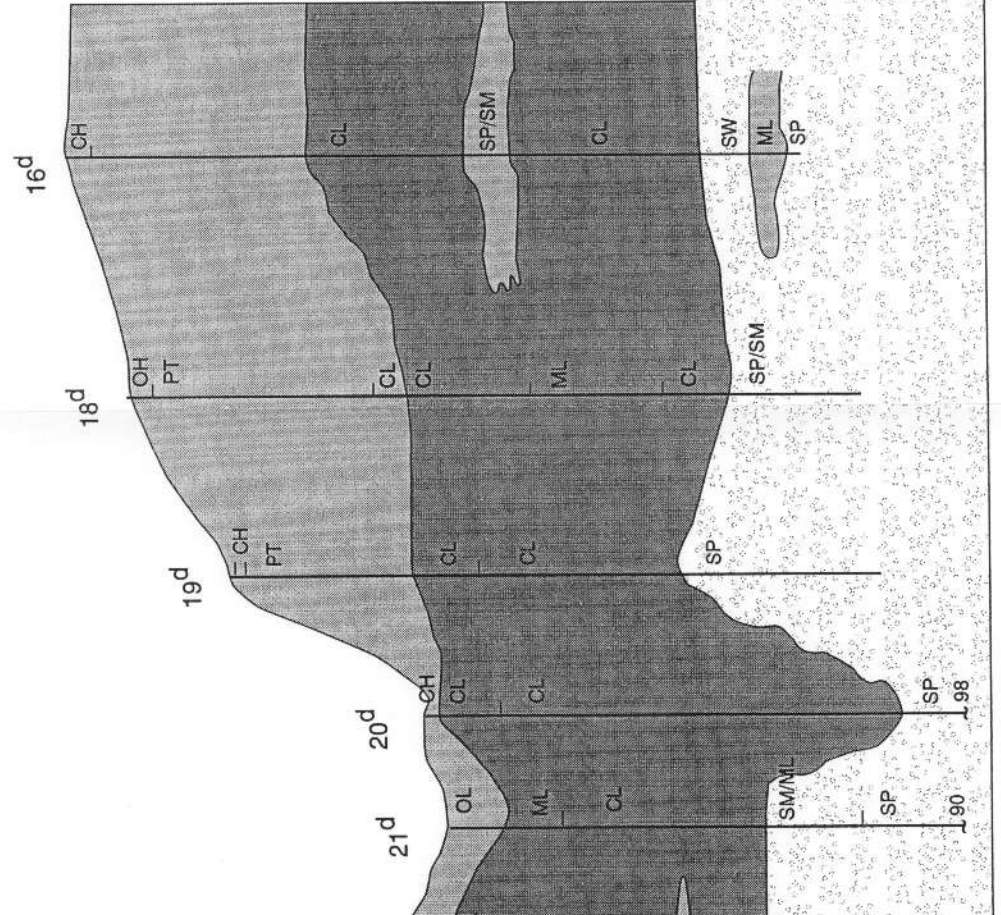
WEST  
B



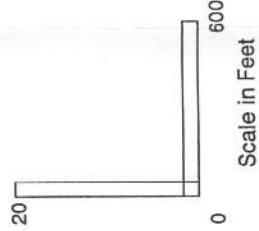
Suisun Bay



Suisun Bay



EAST  
B'



UNIFIED SOIL CLASSIFICATION SYSTEM	
Group Symbol	Typical Name
SP	Poorly-graded sands, gravelly sands, little or no fines
SM	Silty sands, poorly-graded sand-gravel-silt mixtures
SC	Clayey sands, poorly-graded sand-gravel-clay mixtures
ML	Inorganic silts & very fine sands, silty or clayey fine sands, silts with slight plasticity
CL	Organic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
MH	Inorganic silts, micaceous or diatomaceous fine sand or silt
CH	Inorganic clays of high plasticity, fat clays
OH	Organic silts & clays of medium-to-high-plasticity
PT	Peat, humus, swamp soils with high organic content

**LEGEND**

Bay Mud

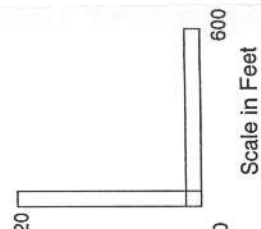
Yerba Buena Muds and Alluvial Clays and Silts

Estuarine Micaceous Sands

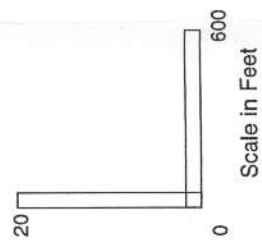
End of Boring, Approximate Elevation in Feet Below Mean Sea Level

Resource for Soil Boring Information:  
d - Dames and Moore, 1966





UNIFIED SOIL CLASSIFICATION SYSTEM	
Group Symbol	Typical Name
SP	Poorly-graded sands, gravelly sands, little or no fines
SM	Silty sands, poorly-graded sand-gravel-silt mixtures
SC	Clayey sands, poorly-graded sand-gravel-clay mixtures
ML	Inorganic silts & very fine sands, silty or clayey fine sands, silts with slight plasticity
CL	Organic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
MH	Inorganic silts, micaceous or diatomaceous fine sand or silt
CH	Inorganic clays of high plasticity, fat clays
OH	Organic silts & clays of medium-to-high-plasticity
PT	Peat, humus, swamp soils with high organic content



UNIFIED SOIL CLASSIFICATION SYSTEM	
Group Symbol	Typical Name
SP	Poorly-graded sands, gravelly sands, little or no fines
SM	Silty sands, poorly-graded sand-gravel-silt mixtures
SC	Clayey sands, poorly-graded sand-gravel-clay mixtures
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CL	Organic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
MH	Inorganic silts, micaceous or diatomaceous fine sand or silt
CH	Inorganic clays of high plasticity, fat clays
OH	Organic silts & clays of medium-to-high-plasticity
PT	Peat, humus, swamp soils with high organic content

### Resources for Soil Boring Information:

a - Lee and Praker, 1966  
b - WESTDIV CODE 411, 1978

Figure 3-1

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

Figure 5-1

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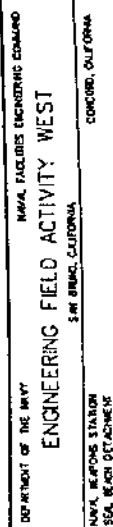


FIGURE 5-2  
GEOLOGIC CROSS SECTION E-E'





VERTICAL SCALE - 20 X HORIZONTAL SCALE

NOTE:  
THIS CROSS SECTION REPRESENTS ONE INTERPRETATION  
BASED ON AVAILABLE DATA. OTHER INTERPRETATIONS  
ARE POSSIBLE.

GOVERNMENT OF THE STATE OF CALIFORNIA  
ENGINEERING FIELD ACTIVITY WEST  
SAN FRANCISCO, CALIFORNIA  
NORTH HAVENPORT STATION  
SOLAR BOILER DETACHMENT  
EASTERN CALIFORNIA

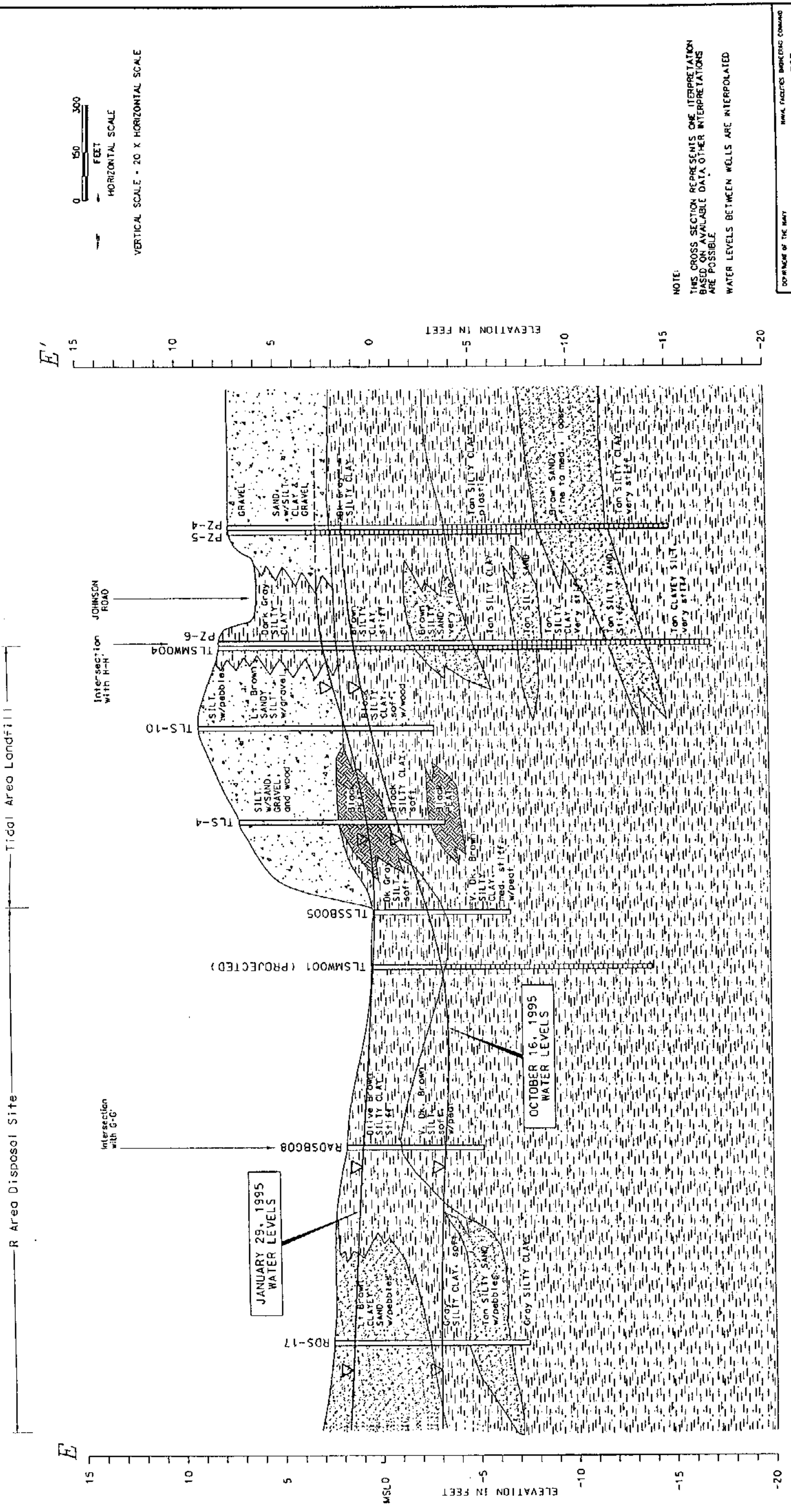
FIGURE 5-3  
GEOLOGIC CROSS SECTION F-F'





## Figures 5-6 - 5-9

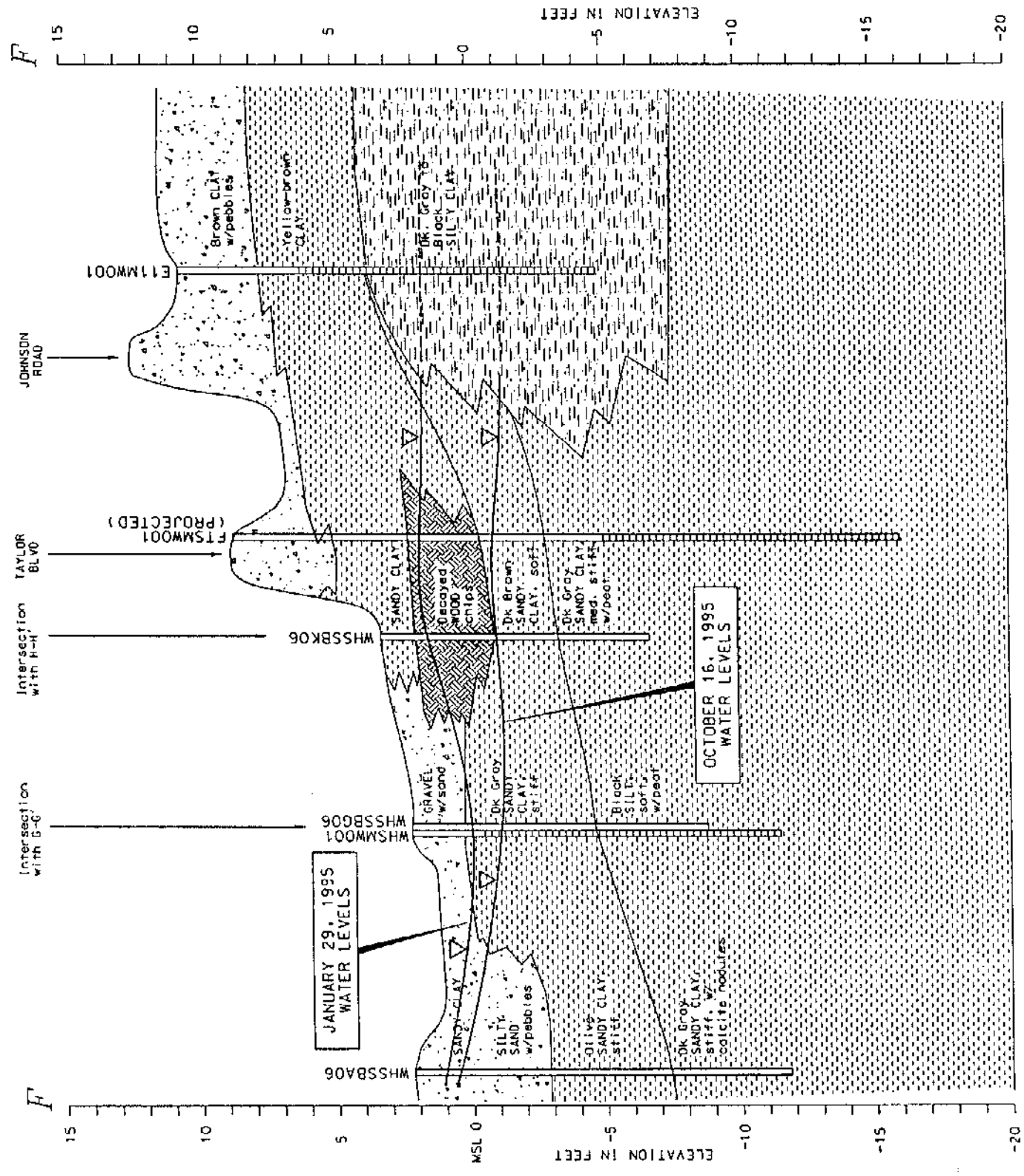
These detailed station maps have been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.



ENGINEERING FIELD ACTIVITY WEST  
S.W. BIRNEY, CALIFORNIA  
CIVIL ENGINEER

FIGURE 5-10  
GROUNDWATER ELEVATIONS ALONG  
GEOLOGIC CROSS SECTION E-E

Wood Hogger Site



NOTE:  
THIS CROSS SECTION REPRESENTS ONE INTERPRETATION  
BASED ON AVAILABLE DATA. OTHER INTERPRETATIONS  
ARE POSSIBLE.  
WATER LEVELS BETWEEN WELLS ARE INTERPOLATED

DEPARTMENT OF THE ARMY  
ENGINEERING FIELD ACTIVITY WEST  
SAND ENGINEERING CENTER  
CORCORAN, CALIFORNIA

FIGURE 5-11  
GROUNDWATER ELEVATIONS ALONG  
GEOLOGIC CROSS SECTION F-F









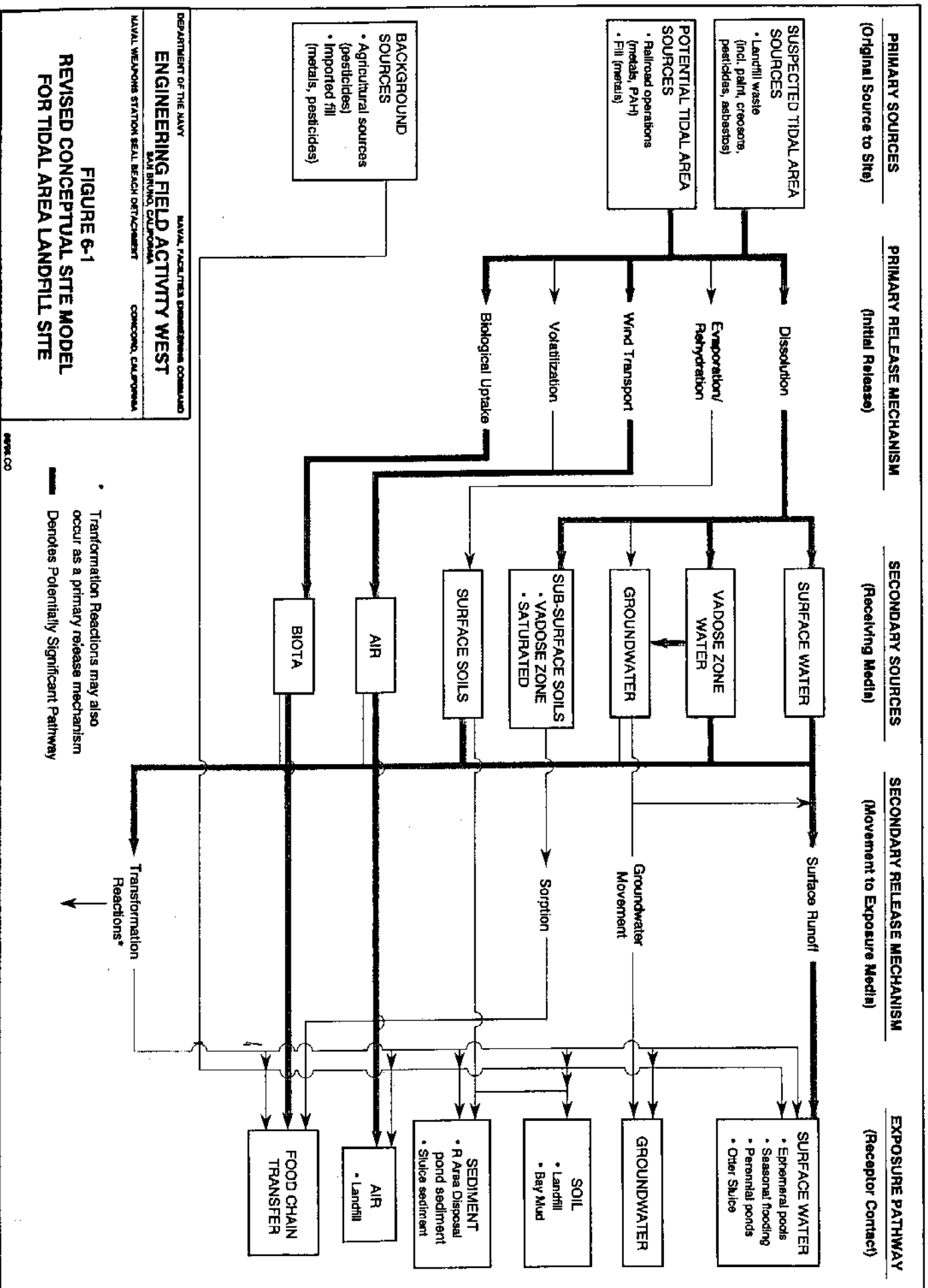
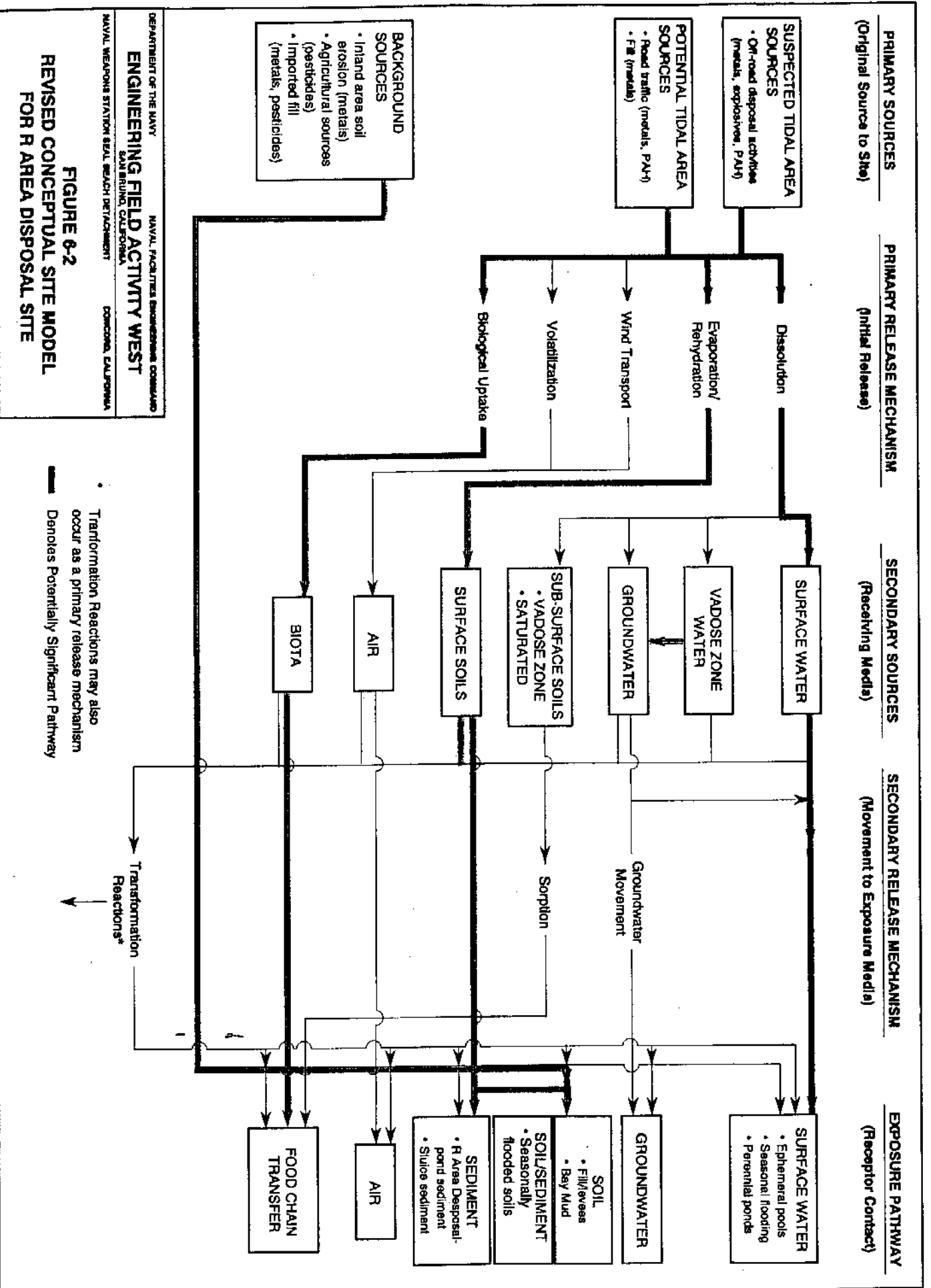
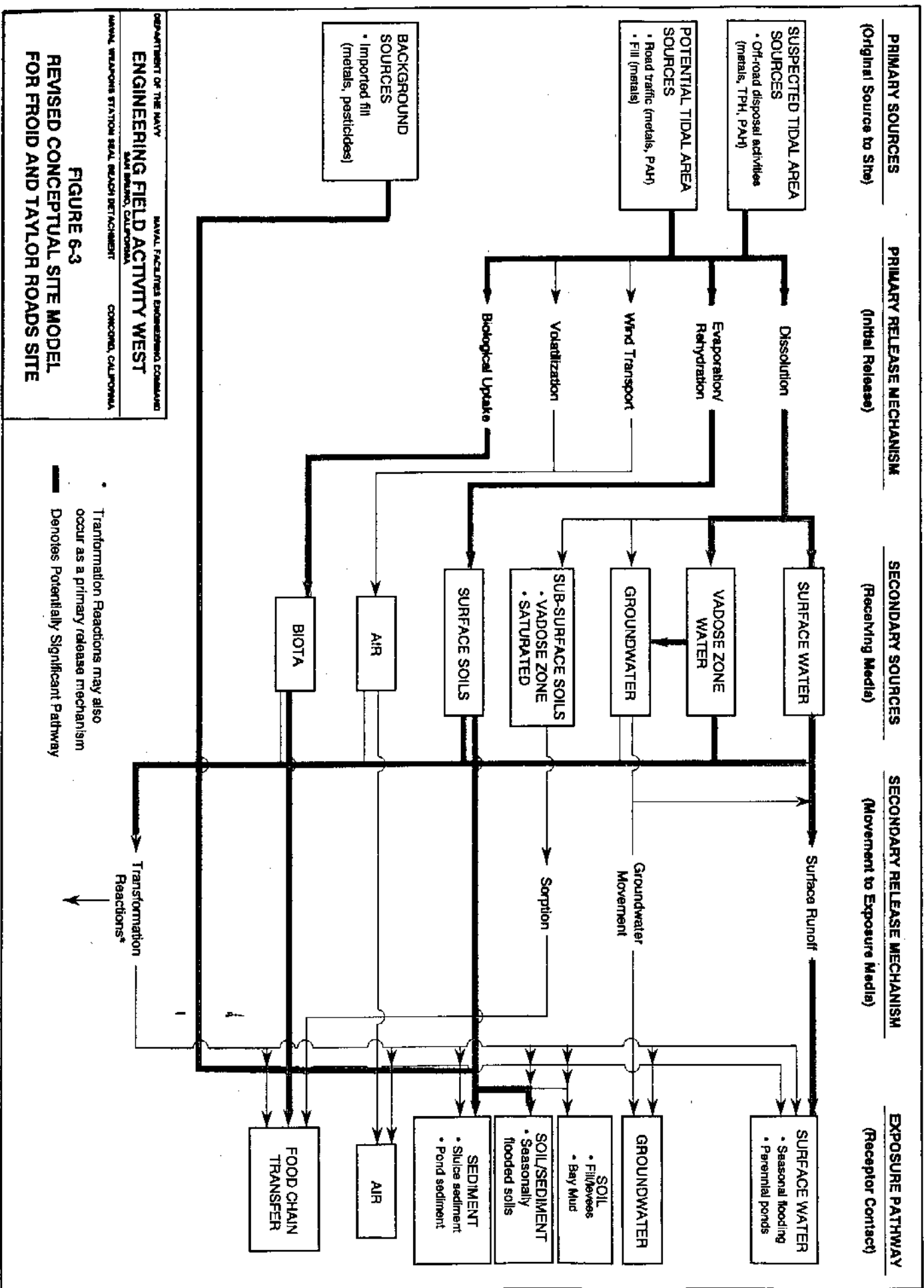


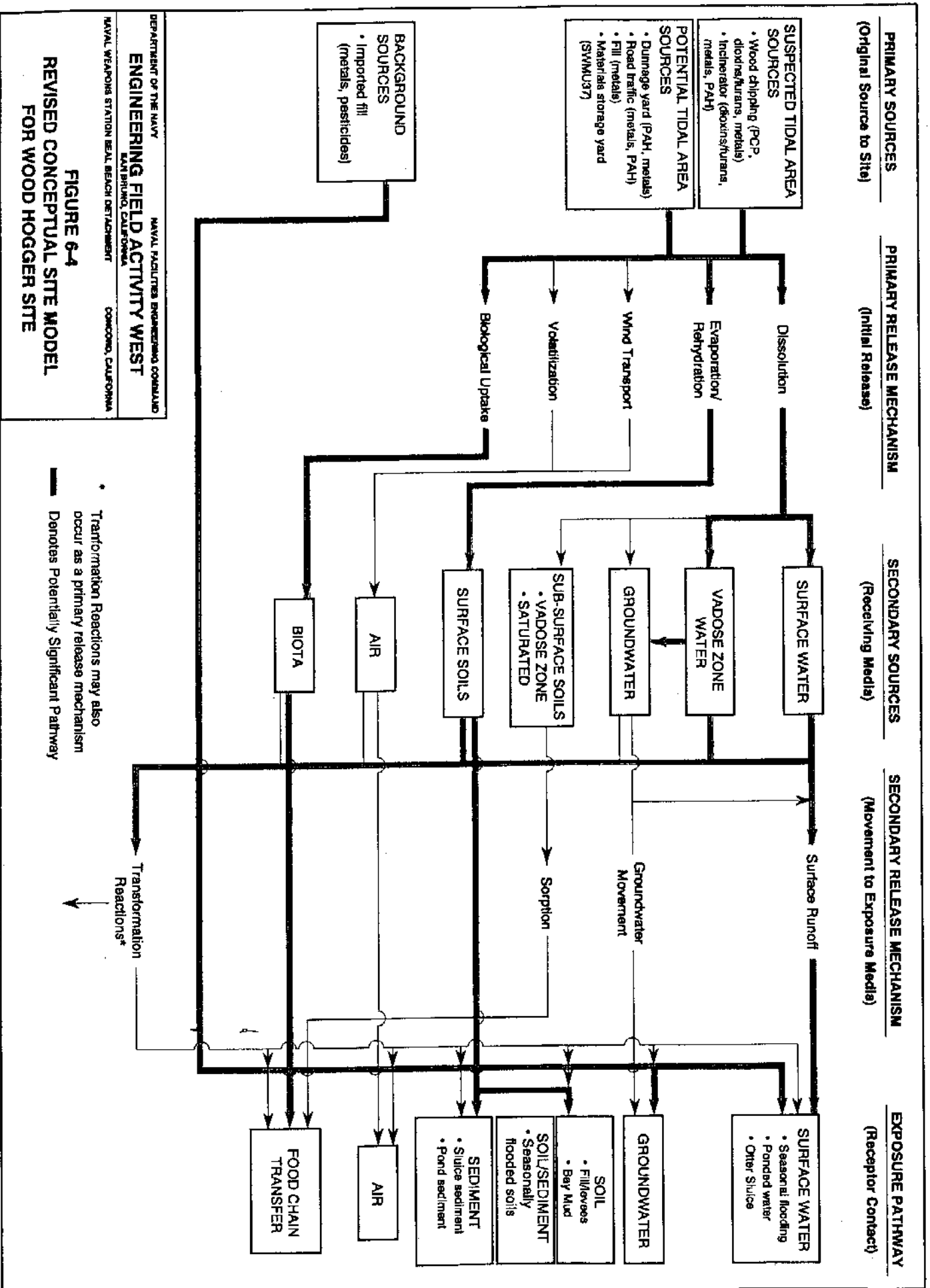
FIGURE 6-1  
 REVISED CONCEPTUAL SITE MODEL  
 FOR TIDAL AREA LANDFILL SITE





**FIGURE 6-3**  
**REVERSED CONCEPTUAL SITE MODEL**  
**FOR FROID AND TAYLOR ROADS SITE**

DEPARTMENT OF THE NAVY  
 NAVAL FACILITIES ENGINEERING COMMAND  
 SAN DIEGO, CALIFORNIA  
 NAVAL REPAIRS STATION SEAL BEACH DETACHMENT  
 CONCORD, CALIFORNIA



DEPARTMENT OF THE NAVY  
 NAVAL FACILITIES ENGINEERING COMMAND  
 ENGINEERING FIELD ACTIVITY WEST  
 SAN PIERRE, CALIFORNIA  
 COMCOM, CALIFORNIA  
 NAVAL WEAPONS STATION SEAL BEACH DETACHMENT  
 FIGURE 6-4  
 REVISED CONCEPTUAL SITE MODEL  
 FOR WOOD HOGGER SITE

Figure 6-5

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